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POWER

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Go to Society Meetings

NO MAN liveth to himself alone.

In one way or another all our acts and interests are bound up with those of others. And the more we do, the more useful we are in the world, to the greater degree is this true.

A wide circle of acquaintance, a host of friends is the best kind of capital a man can have. It not only adds to his value and earning capacity, but it puts joy into life.

The engineer has been accused of a lack of sociability, of shutting himself in with his own thoughts and problems and wonderings.

If he lived more in the open, if he sought contact with his fellows, he would find them wrestling with the same problems and wondering and thinking about the same subjects. And they would be interested in his solutions; his own thinking would be clarified by the process of expression, and he would find help and suggestion in their handling of their difficulties and inspiration in their discussion.

The most helpful friends that one can have are those of his own vocation when that vocation is professional or at least involves some mentality; and the best place to make and meet friends of this sort is at the meetings of associations and organizations of such people.

The redeeming feature of associations that are disappointing in realization of their declared object of educational uplift, is that they do bring their members together in a relationship that, by reason of their common vocational interest, has something broadening and humanizing and satisfying about it. If the attendant at such meetings brings away no addition to his store of knowledge, no inspiration for his thinking or his work, he is at least richer in the friends that he has made.

F. R. Low

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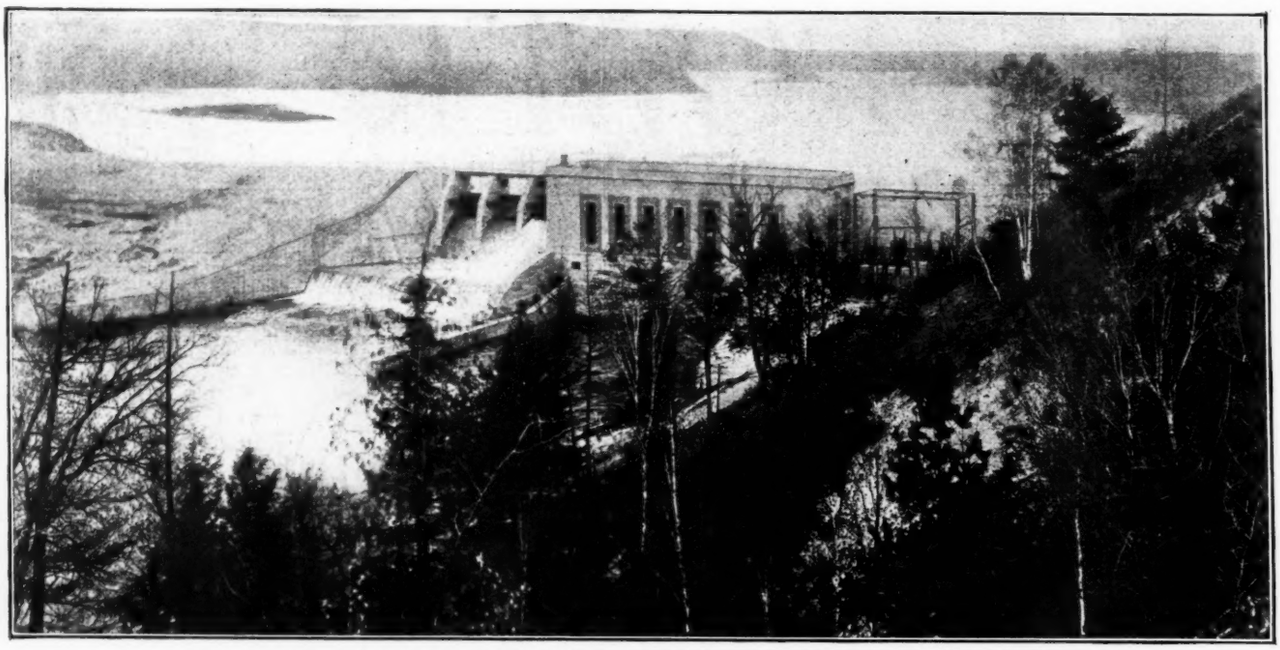


FIG. 1. JUNCTION DAM HYDRO-ELECTRIC PLANT OF 16,500 KW. RATED CAPACITY

System and Operating Methods of Consumers Power Co.

By W. W. TEFFT
Consulting Hydraulic and Civil Engineer, Consumers Power Co.

THE Consumers Power Co., with headquarters at Jackson, Mich., has been a pioneer in high-voltage transmission and a leader in Middle West hydraulic development. Twice this company has developed and built the highest voltage transmission lines in the world. First in 1907, when 70,000 volts was considered the limiting tension for transmission lines, the company built the 40-mile Croton-Grand Rapids tower line for operation at 110,000 volts, utilizing the then newly developed Hewlett type of suspension insulators. Again in 1912, a 140,000-volt tower transmission line was put in operation to transmit the Au Sable River power something over 250 miles. At present there is 526 miles of transmission line operating at this voltage.

Water power is obtained from the Manistee, Au Sable, Muskegon, Grand and Kalamazoo rivers. The entire system comprises 1,300 miles of transmission lines with voltages ranging from 11,000 to 140,000 volts, these lines extending along the eastern, western and southern boundaries of the lower Michigan peninsula in the form of a huge U to serve eighty-nine towns and cities, ten of them being the largest in the state outside of Detroit. There are twenty hydraulic plants having an aggregate rated capacity of 76,110 kw., twelve steam stations designed to develop 85,450 kw. and approximately fifty substations. The company also owns 60,000 acres of land with twenty-eight undeveloped damsites. Tables I and II give individual stations and unit capacities. The accompanying photographic reproductions illustrate several of the leading plants. The entire system is interconnected electrically and may be considered as the first superpower development.

AN EXTENSIVE system of eleven steam plants and twenty hydro stations, supplying power to eighty-nine towns and cities in the State of Michigan. The hydro and efficient steam plants carry the base load, the others the stand-by and peaks. Certain hydro-electric units are operated as synchronous condensers to charge high-capacity transmission lines which total 1,300 miles, ranging from 70,000 to 140,000 volts.

Although the steam and water capacities are about equally divided, it is the plan to obtain maximum output from the hydraulic plants. The steam stations carry the rest of the load, some of the larger and more efficient plants being maintained in constant service, and the others held subject to instant service. Of the half-billion kilowatt-hour output last year, nearly 55 per cent was generated hydraulically.

With thirty-two stations, each capable of feeding into a common system and each supporting the others, there is no occasion for excess reserve capacity in the individual plant, and continuity of service is insured by the multiplicity of the sources of supply.

The first hydro-electric plants were built along the Kalamazoo River, Battle Creek, in 1894; Trowbridge dam, in 1898, transmitting 24 miles to Kalamazoo over a 25,000-volt transmission line; Plainwell Dam, in 1902; Otsego Dam, in 1903; Ceresco Dam, in 1905. In the Battle Creek plant the power equipment consisted of a vertical turbine with a large pulley con-

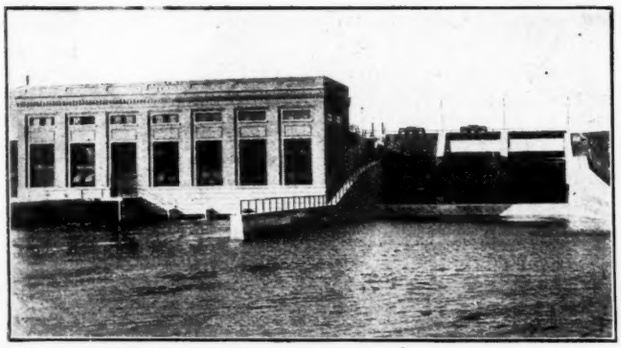


FIG. 2. LOUD HYDRO-ELECTRIC PLANT
The yearly output of this plant is increased by the lapping of heads in a series of dams.

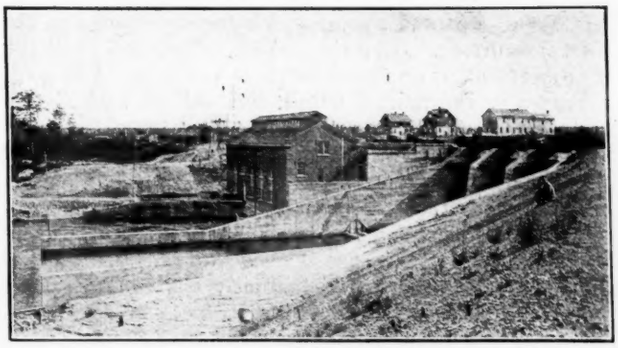


FIG. 3. HYDRO-ELECTRIC PLANT AT COOKE
Contains thirty thousand kilowatt horizontal turbines, operating under forty-foot head.

nected by a quarter-turn belt to a horizontal shaft generator. This plant is running today, as are all of the other hydraulic plants built by the company, and delivering the same amount of power as at first. It is a small plant and represents the small beginning of this great system. Power in each of the other plants on the Kalamazoo River, with the exception of Trowbridge, is generated by a series of vertical turbines, all bevel-geared to a horizontal shaft carrying the generator.

At Trowbridge the machinery arrangement was again simplified as the unit there consists of turbine runners direct-connected to a horizontal shaft which is carried through a watertight bulkhead and direct-connected to a horizontal shaft generator. This method, with the refinements that have been produced by the normal advancement of the art, still maintains for horizontal-shaft plants, with the possible exception that fewer runners are now used per unit.

In many ways the Croton project at the generating end of the 110,000-volt transmission line is notable. It was built in 1906 on the Muskegon River with a head of 40 ft. and the installation of two units totaling 9,000 kw. Each unit was made up of eight runners direct-connected to a horizontal generator shaft at right angles to the direction of the stream flow. The dam has a spillway built upon a soil foundation consisting of eight large Tainter gates separated in the middle by a bear-trap spillway to pass ice, logs or any other débris that might otherwise have an abrasive action on the Tainter gate sills. The bear-trap gate has proved its adaptability for this service. It has operated all these years at Croton without any difficulty whatever.

An interesting feature at Croton was the making of the earth embankment by sluicing from an adjacent hill of higher elevation ot the low cost of 6.8c. per cubic yard. While this method of moving earth had been used before in mining operations in a small way, it never had been applied extensively for dam embankments. Not only was the cost low, but the resulting embankment was dense, as depositing in this way seems to have a beneficial selective effect. The embankment was made tight by means of interlocking steel sheet-piling and a reinforced-concrete core wall. It was predicted at the time that this core wall would break owing to settlement of the embankment, but this has not occurred. In fact, all the embankments built by the company since have been of this type and not one of them has ever failed or leaked through the core wall.

In the eastern section of the state there are five hydraulic plants on the Au Sable River; Cooke, Five Chan-

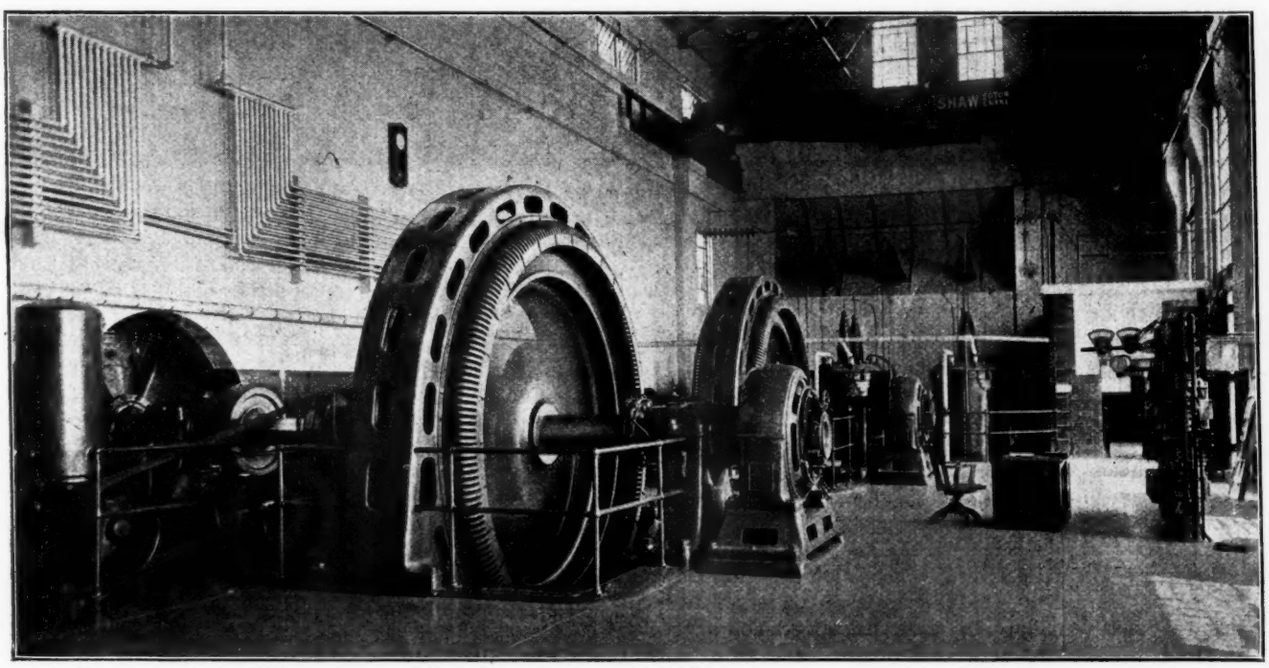


FIG. 4. INTERIOR VIEW OF THE FIVE-CHANNELS HYDRO PLANT

nels, Loud, Mio and Foote, which followed those on the Muskegon River. Here the lapping of heads in a series of adjacent dams on the same river has resulted in large increases in the annual output without additional cost. The method consists in raising the headwater of a downstream dam sufficiently high to raise the tailwater of the next dam upstream some three or four feet, and so on throughout the entire series of dams. The storage resulting is surprising and is effected without loss from evaporation as is the case with a storage reservoir as such. Also this storage is instantly available at every dam in the series without waiting a week or so for the water to come down from some upstream reservoir. All this storage can be used without loss of head except the 4 ft. of extra head at the upstream dam, which may be compared to a total loss of head on a storage reservoir of perhaps 50 or 60 ft. Besides this lapping of heads avoids the cost of a storage reservoir. It should also be noted that the daily fluctuation of load can be taken care of at all the hydraulic plants in the series without any loss of head, which ordinarily amounts to about 8½ per cent of the total power coming down the river.

Of the five installations mentioned, the first three are all horizontal-shaft plants with the shafts extending up and down stream, three units to each plant, each unit composed of two pairs of runners direct-connected to a horizontal shaft, which in turn is direct-connected through a watertight bulkhead to its generator. All these plants deliver their power over a 250-mile 140,000-volt 60 cycle three-phase transmission line to the principal cities along the line.

Mio was the first modern vertical-shaft plant built by the company. It was erected on a sand foundation with an embankment of the same kind of "hour-glass" sand as the foundation, and made watertight with sheet-piling and a thin, reinforced-concrete core wall. The power house itself is supported on round wood piling. Probably the most notable feature about this plant is the first use of the so-called conduit spillway.

In 1920 the Plainwell Dam was rebuilt on account of the destruction of the old power house by fire. Its design will compare favorably with that of any small hydro-electric plant in the country. The power equipment consists of three vertical direct-connected units of 320 kw. each, running under a 13-ft. head at 164 r.p.m., made possible by the use of Nagler-type, four-blade runners. The advantages of this type of runner are its simplicity, freedom from clogging from débris in the river, resulting reliability and high specific speed, which decreases materially the generator cost and results in a flatter efficiency curve over a considerable range of head fluctuation. With a head as low as 13 ft. this is a distinct advantage, as the percentage of head fluctuation is bound to be greater than in a high-head plant.

To prevent air from entering the turbines owing to the shallow depth of water above them, the penstock above the turbine was made airtight and the air ejected

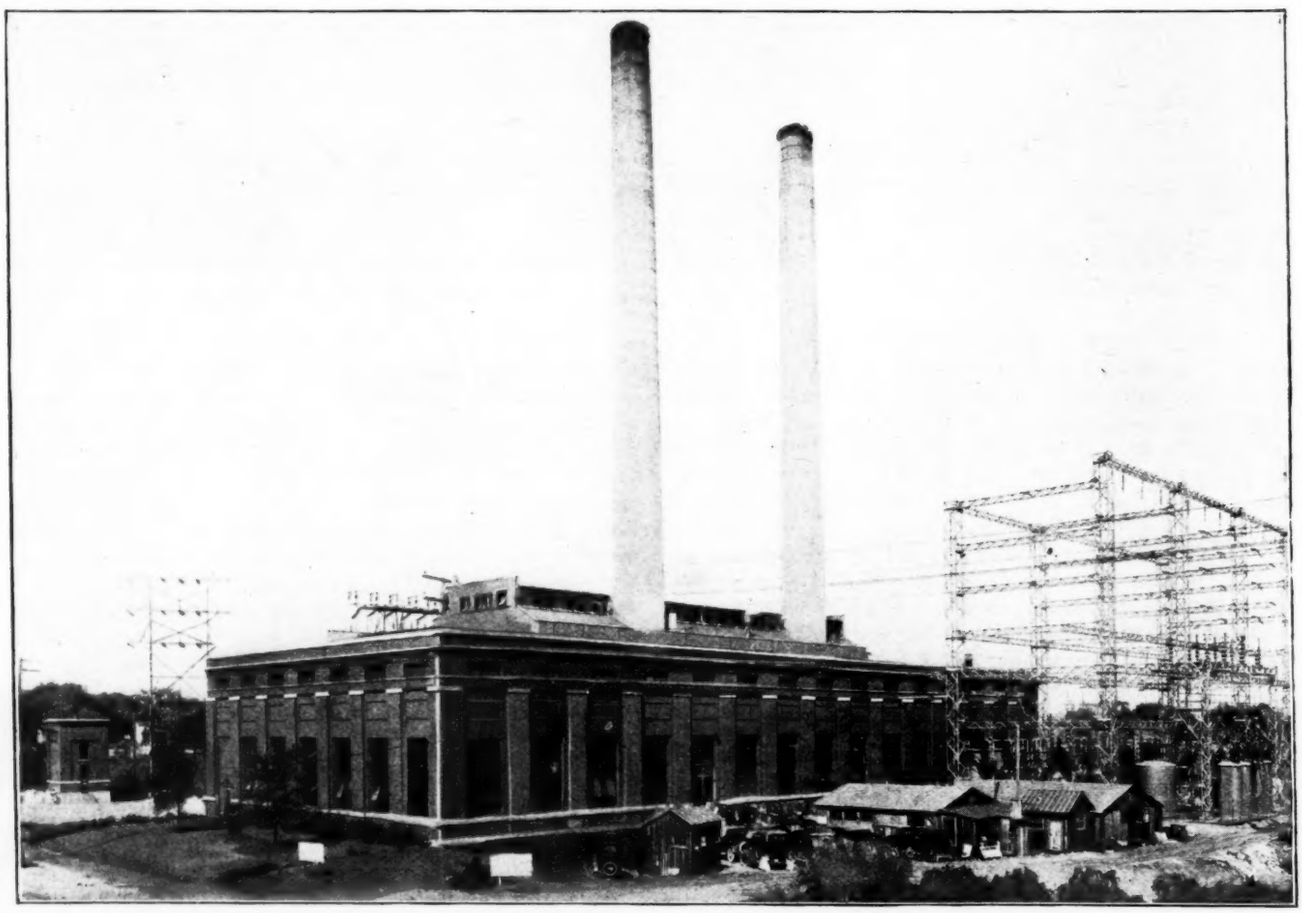


FIG. 5. BATTLE CREEK STEAM GENERATING STATION OF 27,500 KW. CAPACITY
This plant is operated continuously at high load factor.

from it by means of a small hydraulic ejector in the draft tube, so that the elevation of the headwater just above the turbine is some four feet above the headwater elevation outside the power house. This development was one of the first to use the Hydraucone draft tube.

Junction dam on the Manistee River is the largest and best-equipped hydro-electric plant on the system and is the largest plant in the southern peninsula of the state. It has three vertical, direct-connected units with an aggregate capacity of 16,500 kw. and operating at a standing head of 50 ft. For a plant of this size the turbine efficiency is extremely high, being only slightly under 93 per cent. Each unit is protected by a Tainter head gate and has stop-log grooves in the tailrace so that it can be isolated from the rest of the plant in case any repair or inspection is necessary.

Plans are now under way for a sixth plant on the Au Sable River, the Alcona development, which will be a step in advance of its predecessors. In addition to the various outstanding features already mentioned, Alcona will combine both the spillway and power house in one simple structure forming almost exactly a cube, which represents the minimum construction and foundation cost and practically eliminates any danger from settlement. There will be no spillway outside of the power house. All the waste water will be discharged underneath the power house into the tailrace below the surface of the tailwater. This spillway will be controlled by six butterfly valves operated by simple mechanism from within the generator room. Besides avoiding the necessity for the operator leaving the units, this method of spilling water has the advantage of silence; safety to foundations during times of spilling; immunity to freezing shut; some head increaser effect and, more than all, the great reduction in construction costs, amounting in some cases to as much as 41 per cent of the total.

Units Operate as Synchronous Condensers

In connection with the operation of the hydraulic plants an interesting practice has been the use of vertical direct-connected hydro-electric units as synchronous condensers. This method of charging long and high-capacity transmission lines without the wasting of water through the plants was original with the company. Early experiences with these high-capacity lines showed that it was necessary to have considerable generator capacity at all times, even during the night, when there was little load, for the sole purpose of charging the line. This was an expensive procedure because it required the operation of several hydro-electric units to produce the requisite kilovolt-ampere capacity when only a small amount of actual kilowatts was being delivered to the line. The use of these several turbines at low gate openings resulted in a great waste of water because the efficiency of a hydraulic turbine at small gate opening is low, sometimes dropping to 30 or 35 per cent, where a larger gate opening on the same turbine would give an efficiency of over 90 per cent. In the plants having vertical, direct-connected units it was found when three units were required to charge the line, that all three could be phased in on the line and then the water shut off from two of them and all the real power carried on one unit at an efficient gate opening, air being admitted to the draft tubes of the coasting machines to avoid the loss of power in the draft tubes.

Four Class A Steam Plants

Of the twelve steam plants connected to the system, four at Battle Creek, Grand Rapids, Flint and Jackson, respectively, are large Class A plants that are either on the line continuously or are ready for immediate service. The other eight are smaller stand-by plants that can be brought into service on short notice. The four large plants are modern, a considerable portion of the equipment having been added within recent years, and this is particularly true of the Battle Creek plant, which has just been remodeled, is up to the minute in all its equipment and is highly efficient. It is not the usual steam relay plant, as it is operated continuously at high load factor. Being more efficient, it carries as much of the steam load as possible in order that the load on the less economical steam plants on the system may be reduced. The plant has a capacity of 27,500 kw. in three units and is served by six cross-drum water-tube boilers each having 8,700 sq.ft. of steam-making surface. The boilers are equipped with underfeed stokers provided with variable-speed direct-current motors and alternating-current motors and mechanical speed-varying devices for driving the clinker rolls. Both forced and induced draft are employed, as the boilers are equipped with cast-iron baffled economizers. Coal and ash handling inside the boiler house is carried on in inclosed rooms to prevent dust reaching the mechanical equipment and spreading throughout the plant. Duplicate evaporator units to provide makeup to the extent of 10 per cent of the feed-water requirements have been installed and exhaust steam piped to indirect radiation may be used to preheat air for the furnace. Using some of the available exhaust steam in this way reduces the feed-water temperature to as low as 150 deg., thus giving a more economical range for the economizers.

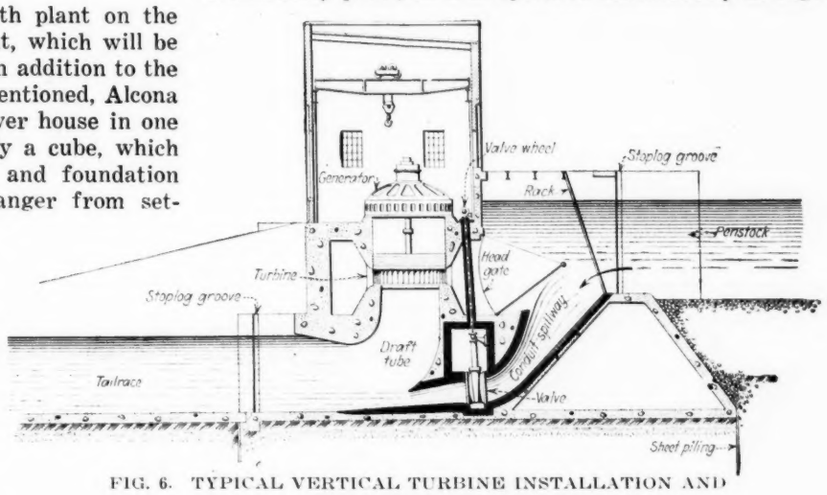


FIG. 6. TYPICAL VERTICAL TURBINE INSTALLATION AND CONDUIT TYPE SPILLWAY

The earth foundation is sealed against leakage by the extensive use of steel sheet piling.

At Grand Rapids the Wealthy Street steam plant has a rated capacity of 22,000-kw. in three generating units. The boiler plant has eight 6,000-sq.ft. Stirling units with chain grate stokers and two Stirling boilers, added recently, each with 23,650 sq.ft. of steam-making surface, and equipped with two 13-retort underfeed stokers.

At Flint the generating capacity is 13,500 kw. in three

units, and the boiler room has eight Stirling boilers with 48,000 sq.ft. of steam-making surface, served by underfeed stokers. Jackson is the smallest of the four Class A plants, having a generator capacity of 9,000 kw. in two units and corresponding boiler capacity.

The steam plants with capacities and location, are shown in Table II.

TABLE I—CAPACITIES AND NOMINAL HEAD OF THE TWENTY HYDRO-ELECTRIC PLANTS ON CONSUMERS POWER COMPANY'S SYSTEM

	No. of Units	Capacity of Units (Kw.)	Rated Capacity of Plant (Kw.)	Nominal Head (Ft.)
Junction	3	5,500	16,500	50.0
Stronach	2	400	800	18.0
Rogers	2	2,250	4,500	38.0
Croton	2	4,500	11,900	40.0
	2	1,450		
Lowell No. 1	2	300	600	30.0
Grand Rapids, West Side	2	200	400	...
Allegan	2	200	400	9.0
Trowbridge	1	1,500	1,500	21.0
Otsego	1	1,500	1,500	15.0
Plainwell	1	960	960	13.0
Battle Creek	1	150	150	9.0
Ceresco	2	300	600	14.0
Albion	1	150	150	12.0
Webber	1	3,000	3,000	26.0
Shiwassee	1	150	150	10.0
Cooke	3	3,000	9,000	40.0
Foote	3	3,000	9,000	35.0
Five Channels	2	3,000	6,000	35.0
Loud	2	2,000	4,000	26.0
Mio	2	2,500	5,000	29.0
Total rated capacity of hydro-electric plants			76,110	

TABLE II. TWELVE STEAM-ELECTRIC GENERATING STATIONS WITH A TOTAL RATED CAPACITY OF 85,450 KW.

Stations	No. of Units	Capacity of Units Kw.	Rated Kw. Capacity Of Plant
Grand Rapids, Wealthy St.	1	4,500	22,000
	1	7,500	
	1	10,000	
Grand Rapids, Market Avenue	1	.....	3,600
Kalamazoo	1	.....	3,000
Battle Creek, Elm Street	1	7,500	27,500
	2	10,000	
Battle Creek Heating Plant	...	...	350
Jackson	1	7,500	9,000
	1	1,500	
Flint	2	3,000	13,500
	1	7,500	
Saginaw No. 1	1	.....	2,500
Bay City	1	.....	1,500
Manistee	1	...	500
Cadillac		350	700
Pontiac		650	1,300
Total rated capacity of steam plants			85,450

Pointers on Oil Systems in Hydro-Electric Plants

By R. C. Denny*

The proper lubrication of the bearings of the main units and exciters, while quite an important requisite, is fortunately rather a simple matter, in fact almost unbelievably simple in the case of the Kingsbury bearing. This does not imply, however, that lubrication systems do not require their share of routine attention in station operation, but that in hardly any case is the system very extensive or complicated. In the case of small horizontal units the oil system is self-contained in the bearings themselves and the oil is applied to the shaft by means of rings revolving on them. In larger units of this type the oil reservoir in the bearing is water-jacketed and the oil thus cooled by water from the penstock.

In some of the larger horizontal units the oil is constantly changed as well as the cooling water. Such is the practice at one station of the San Joaquin Light and Power Corp., a four-unit 16,000-kva. plant. The oil is pumped by a small motor-driven direct-connected centrifugal pump to an elevated tank, whence it is distributed by gravity to the bearings of all the main units. In the bearings the oil is maintained at a constant level by an overflow pipe that drains to the filter tank en route to the main reservoir. This system has a capacity of 500 gal. and furnishes oil for practically all other purposes about the station. Another expedient at this station in connection with the cooling situation is the circulation of water through the hollow shafts of the main units.

In the modern stations the tendency, however, is to make the lubricating-oil system integral with the unit. Such is the practice with the units at Kerckhoff and Kern Canyon stations. The lubrication for the guide bearings of these units is provided by small pumps geared to the mainshafts. This pump is located in the oil reservoir just below the lower guide bearing and forces oil up into a small tank on top of the unit, whence it is fed by gravity to the upper guide bearing. From there it drains down through a small pipe in the rotor to the lower guide bearing and thence to the reservoir. In the pressure lines from the pumps are sight-feed indicators which show the flow. This same system is used for the guide bearings of the exciters; water coils are provided in the oil reservoir in all cases, allowing for the circulation of cooling water. The oil for the Kingsbury bearings is contained in a reservoir about the bearing and no method of circulation is provided other than that due to the centrifugal effect of the runner plate. Water cooling coils are provided, however, with sight-flow indicators, so that in all, it is a simple and reliable system of lubrication.

In most of the stations the main power transformers are cooled by circulating water from the penstock through coils placed in the oil, and only in one case is the oil circulated. The latter is without doubt the safer method, however, for in the event of a leak it is the oil that gets out and not the water that gets in. Furthermore, any deposit from the water is on the outside of the pipe where it cannot interfere greatly with the cooling and can be removed if necessary without a great deal of trouble. This system, however, entails the constant expense of operating the motor-driven oil pump, and it is possible that the saving in water justifies this, as at this particular station the water is used through a head of nearly 1,500 feet.

At several of the stations tanks are used to guarantee a sure supply of cooling water always, and in one or two cases two tanks are used, one as a settling basin and emergency capacity, overflowing into the second tank, from which the water is piped to the transformers. Floats are used in such cases to operate valves preventing overflow and waste of water. Such systems of water-cooling transformers have proved adequate and reliable, having given no trouble in many years of operation.

Only the usual standard types of water pressure and level instruments are used, both for indicating and recording purposes, and these have proved to be in general reliable. The greatest difficulty experienced has been with the long-distance indicators owing to their pressure elements leaking. However, when in good repair they are superior to float indicators with their usual complication of contacts, lamps and wires.

[This article is part of a paper to be submitted at the Pacific Coast Section of the N. E. L. A.—Editor.]

*Operating Engineer, San Joaquin Light and Power Corporation.

Percentage of Boiler Rating

What Does It Mean? How Is It Figured?

"THE boiler was operated at 180 per cent of rating without difficulty." Expressions like this frequently occur during discussions at engineering society meetings or in articles on boiler operation. What do they mean?

Does the statement just quoted mean that the boiler was carrying 80 per cent more load than the manufacturer would recommend, or that the boiler was operating 80 per cent above its safe limit or its point of best efficiency? In each case the answer is No. What it really means is that the boiler was producing 80 per cent more steam than it is rated to produce on the basis of a certain arbitrary rule. This rule assumes that a square foot of heating surface in any boiler, or at least in any stationary water-tube boiler, should normally evaporate a certain amount of water per hour under certain conditions, regardless of the type of boiler, setting, method of firing or anything else. The rule was made years ago and generally adopted. There is no harm in using it if the user understands that the rating of the boiler does not represent what it can do or ought to do nowadays, but merely what it was thought years ago that a boiler of this size ought to do.

Boiler Rating Based on Heating Surface

This rule may be stated as follows: Every stationary water-tube boiler is rated to evaporate 3.45 lb. of water per hour "from and at" 212 deg. F. for every square foot of heating surface.[1]

The term "from and at 212" needs explanation. It means that feed water comes to the boiler at 212 deg. F. and that the gage pressure on the boiler is zero. At that pressure (14.7 lb. per sq.in., absolute) water boils at 212 deg. F. The feed water has merely to be evaporated at atmospheric pressure. This requires 970.4 B.t.u. (heat units) for every pound of water evaporated.

In actual practice the feed-water temperature is ordinarily less than 212 and the boiler pressure much above zero gage. Under such conditions it always takes more than 970.4 B.t.u. to make a pound of steam, so that full rating does not call for the evaporation of 3.45 lb. per sq.ft. in this case.

Rated Evaporation for Actual Conditions

For example, suppose the feed-water temperature is 190 deg. F., and the boiler pressure 150 lb. gage. Assume also that the steam is dry and saturated (not superheated). Then the heat required to make one pound of steam is evidently the difference between the heat in one pound of steam and the heat in one pound of feed water. The heat in one pound of dry saturated steam at 150 lb. gage pressure (165 lb. absolute pressure) is 1,195 B.t.u. This figure was obtained from the steam tables. To get the heat in the water it is only necessary to subtract 32 from the temperature, so the heat in one pound of feed water at 190 deg. is 190 — 32 = 158 B.t.u. The heat required to produce a pound of steam is then 1,195 — 158 = 1,037 B.t.u.

To evaporate a pound "from and at 212" took only 970.4 B.t.u., so it is 1,037 ÷ 970.4 = 1.068[2] times as hard to make a pound of steam under the given conditions as under the standard "from and at 212" condition. So, since 3.45 lb. per hr. is the rated evaporation per square foot "from and at 212," the rated evaporation under the given conditions should be less. In fact, it would be 3.45 ÷ 1.068 = 3.23 lb. per sq.ft. per hour.

Table Simplifies Computations

As it is somewhat laborious to figure this all out each time the steam pressure and feed-water temperature change, the accompanying table has been computed to give the answer directly. This table shows the rated evaporation per square foot of heating surface per hour, for different feed temperatures and steam pressures.

For example, if the gage pressure is 140 lb. per sq.in. and the feed-water temperature is 200 deg. F., standard rating calls for the evaporation of 3.26 lb. of water per square foot per hour. If the boiler has 2,000 sq.ft. of water-heating surface (measured on the fire side of the tubes) the rated capacity at this pressure and feed-water temperature is 3.26 × 2,000 = 6,520 lb. of steam

[1] This is the simplest but not the most common method of stating the rule. Ordinarily, the idea of boiler horsepower is introduced. The term "boiler horsepower" has two distinct meanings, neither of which has much connection with "horsepower" as used elsewhere in engineering work. "Rated boiler horsepower" is really nothing but a measure of heating surface, since boilers are ordinarily rated on the basis of 10 sq.ft. of heating surface per boiler horsepower. "Developed boiler horsepower" is a measure of evaporation, which is an entirely different matter from heating surface. A developed boiler horsepower is defined as the evaporation of 34.5 lb. of water per hour "from and at 212." Combining these two definitions, we see that when each 10 sq.ft. of heating surface is evaporating 34.5 lb. of water per hour "from and at 212," the boiler is working at its rated capacity. This is the same as saying that each square foot is evaporating 3.45 lb., as stated in the body of the article. It is evident that "boiler horsepower is an unnecessary unit which can always be replaced by "heating surface" or "evaporation."

[2] In this case 1.068 is known as the "factor of evaporation."

RATED EVAPORATION PER SQ.FT. PER HR. EQUIVALENT TO 3.45 LB. "FROM AND AT 212."

Feed Water Temperature, Deg. F.	Steam Pressure, Lb. per Sq.In., Gage (Dry, Saturated Steam)														
	0	5	10	20	40	60	80	100	120	140	160	180	200	220	240
60	2.98	2.97	2.96	2.94	2.92	2.90	2.89	2.88	2.88	2.87	2.86	2.86	2.86	2.86	2.85
70	3.01	3.00	2.98	2.97	2.95	2.93	2.92	2.91	2.90	2.89	2.89	2.88	2.88	2.88	2.88
80	3.04	3.02	3.01	2.99	2.97	2.95	2.94	2.93	2.92	2.92	2.91	2.91	2.91	2.90	2.90
90	3.06	3.05	3.04	3.02	3.00	2.98	2.97	2.96	2.95	2.94	2.94	2.94	2.93	2.93	2.93
100	3.09	3.08	3.06	3.05	3.03	3.01	2.99	2.98	2.98	2.97	2.96	2.96	2.96	2.96	2.95
110	3.12	3.11	3.09	3.08	3.05	3.03	3.02	3.00	3.00	3.00	2.99	2.98	2.98	2.98	2.98
120	3.15	3.13	3.12	3.10	3.08	3.06	3.05	3.04	3.03	3.02	3.02	3.01	3.01	3.01	3.00
130	3.18	3.17	3.15	3.13	3.11	3.09	3.08	3.07	3.06	3.05	3.05	3.04	3.04	3.03	3.03
140	3.21	3.20	3.18	3.16	3.14	3.12	3.10	3.09	3.09	3.08	3.08	3.07	3.07	3.06	3.06
150	3.24	3.23	3.21	3.19	3.17	3.15	3.13	3.12	3.12	3.11	3.10	3.10	3.10	3.09	3.08
160	3.27	3.26	3.24	3.22	3.20	3.18	3.16	3.15	3.14	3.14	3.13	3.13	3.12	3.12	3.12
170	3.31	3.29	3.28	3.26	3.23	3.21	3.19	3.18	3.18	3.17	3.16	3.16	3.15	3.15	3.15
180	3.34	3.32	3.31	3.29	3.26	3.24	3.22	3.21	3.20	3.20	3.19	3.18	3.18	3.18	3.18
190	3.37	3.35	3.34	3.32	3.29	3.27	3.26	3.24	3.24	3.23	3.22	3.22	3.21	3.21	3.21
200	3.41	3.38	3.37	3.35	3.32	3.30	3.29	3.28	3.27	3.26	3.26	3.25	3.24	3.24	3.24
210	3.44	3.42	3.41	3.38	3.36	3.33	3.32	3.31	3.30	3.30	3.29	3.28	3.28	3.27	3.27

per hour. Suppose that, by measuring the steam with a steam-flow meter or the feed-water with a water meter, it is found that the boiler is actually evaporating 9,200 lb. of water per hour. Then the "per cent of rating" is (9,200 ÷ 6,520) × 100 = 141 per cent. That is to say, the boiler is operating 41 per cent above rating.

The table is for saturated steam only. For superheated steam it would be necessary to use the steam tables to get the heat in the superheated steam and then to figure the rated evaporation in the manner illustrated earlier in this article. However, a result sufficiently close for most purposes can be obtained by subtracting 0.16 lb. for each 100 deg. of superheat from the figures given in the table.

For example, suppose the steam is at 200 lb. gage pressure and superheated 150 deg., while the feed-water temperature is 160 deg. F. The table gives 3.12 as the rated hourly evaporation per square foot for saturated steam. We must deduct 0.16 lb. for each 100 deg. of superheat. So for 150 deg. superheat we deduct 1½ × 0.16 = 0.24 lb., giving 3.12 — 0.24 = 2.88 lb. as the rated evaporation per square foot per hour. If this had been figured accurately from the steam tables, the answer obtained would have been 2.90 lb. The difference is less than one per cent.

How To Use the Willans Line

Simple Instructions for Its Use in Checking and Extending the Results of Steam-Consumption Tests

THERE is nothing new about the "Willans Line." It is an old idea that has given years of excellent service, yet many engineers are still unfamiliar with it and its use. It will pay such to spend a few minutes in learning the "what and how" of this useful method, which is a reliable check on the accuracy of water-rate curves and is, at the same time, easily understood and applied.

If the total steam used per hour by a throttle-governed engine or steam turbine (with a fixed number of nozzles in use) is plotted against the horsepower or kilowatt output, the result will be a straight line. This is called the Willans Line. The same name is often applied to the total-steam-consumption line of other types of engines and turbines, although these do not ordinarily give a perfectly straight line.

Confining ourselves for the present to the case of throttle-governed engines or turbines, if the results of a test so plotted do not lie on a straight line or nearly so, the test is shown to be unreliable. So it is wise to make such a chart while an engine or turbine test is in progress, plotting the total steam consumption at various loads as soon as the readings have been taken. In this way irregularities due to errors of testing appear at once, so that they can be corrected before finishing the test. When a reliable test is completed, it will be possible to draw a single straight line that passes either through or very close to all the points.

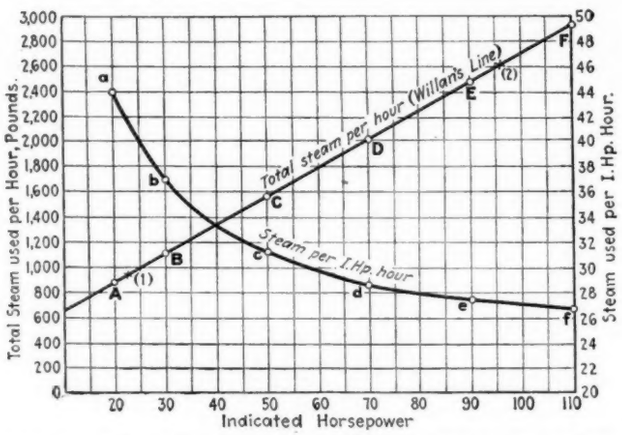
If this line has been plotted on a liberal scale, the water-rate curve can easily be figured from it. This will give a smoother and more reliable water-rate curve than could be obtained directly from the original test results.

As an example of the use of the Willans Line, suppose that the total steam consumption of a throttle-governed engine has been accurately determined at two points as follows:

Point	Indicated Horsepower	Total Steam Used per Hour, Lb.
(1)	22.5	940
(2)	96.0	2,620

These two points are plotted as shown in the figure (using the left-hand scale for total steam used) and a straight line is drawn through them. If the two points have been accurately determined, the line drawn is a reliable Willans Line showing the total steam consumption at any load.

It is then possible to figure the water rate at any load by dividing the total steam used by the corresponding indicated-horsepower. For example, the total steam consumption at an indicated-horsepower of 20 (point *A*) is 880 lb. per hour, giving a water rate of 880 ÷ 20 = 44.0 lb. per i.hp.-hr. The curve showing the water rates at various loads may be plotted on a separate sheet of paper or on the same sheet, as indicated in



USE OF WILLANS LINE TO PLOT WATER-RATE CURVE

the figure. In the latter case the scale for water rate (steam used per i.hp.-hr.) is placed on the right.

In the example shown, a series of points, *A*, *B*, *C*, *D*, *E* and *F*, has been selected, the water rate computed for each and plotted as *a*, *b*, *c*, *d*, *e* and *f*. A smooth curve drawn through the latter series of points is the "water-rate curve." The following table shows the computations:

Point	I. Hp.	Total Steam Lb. per Hr. (to Nearest 10 Lb.)	Lb. Steam per I.Hp.-Hr. (3) ÷ (2)
A	20	880	44.0
B	30	1,110	37.0
C	50	1,560	31.2
D	70	2,010	28.7
E	90	2,470	27.4
F	110	2,920	26.5

More reliable results can be obtained if test results for three or more points are available. It should then be possible to draw a straight line close to them all.

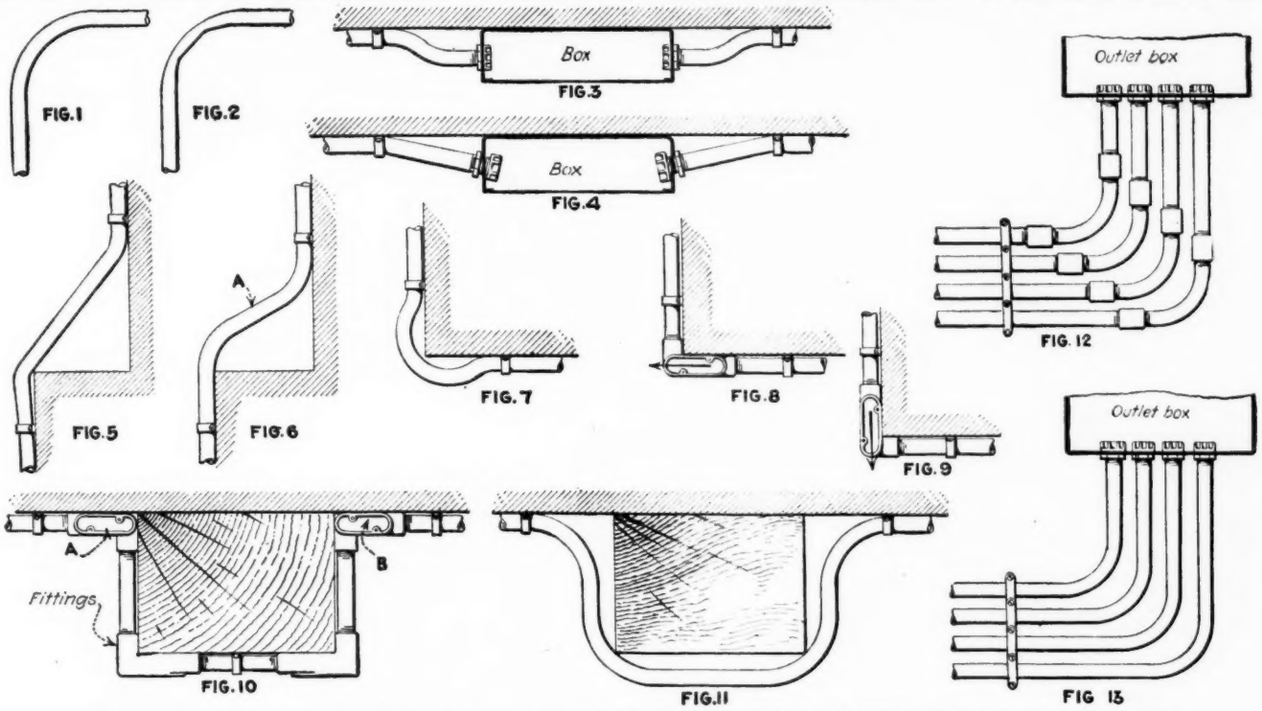
It should be carefully noted that the method just described cannot be applied, without modification, to an engine that governs by changing the cutoff. In such cases the line will be slightly concave on the upper side. In the case of turbines that govern by a combination of throttling and the cutting in of additional nozzles, there will be one Willans Line if a single nozzle is used, another for two nozzles and so on. That is, the total steam consumption plotted against the output in kilowatts will follow one Willans Line as long as only one nozzle is in use and jump to a higher Willans Line each time a new nozzle is cut in.

Installation of Metal Conduit

Practices That Contribute To Doing a Good Conduit Job and Practical Examples of Proper Methods

BY W. A. HEFNER

THERE are various ways of running electric circuit, but conduit, when installed properly, offers the greatest security to the wiring. However, owing to the way these jobs are sometimes done, a large part of the advantage of the conduit is lost. The conduit is improperly bent and fitted, is not adequately supported and the ill-advised use of fittings makes the whole job a sad spectacle, where, with a little care and slight additional expense the installation could be made a credit to those who did the work and would be free from trouble after being put into service. A conduit job that is installed in a good mechanical manner is also a good electrical job, so there can be no excuse for doing inferior work.



FIGS. 1 TO 13. EXAMPLES OF CORRECT AND INCORRECT METHODS OF INSTALLING METAL CONDUIT

In bending conduit, care should be taken to get a good smooth bend as in Fig. 1, and not to kink the bend as indicated in Fig. 2. A kinked bend may crack the conduit and cause cutting of the insulation on the wires when they are pulled in. If this does not happen, the reduction in the pipe size at the kink may make it difficult to pull in the wires. Even if neither of these difficulties is encountered, the kink makes a bad-looking job and should be avoided for this reason alone. Kinking of the conduit is caused by not moving the hickey when making the bend. The pipe should be bent about 20 deg. and the hickey moved one or two inches and bent about 20 deg. more and so on until the required bend is obtained. With large pipe various devices are used in making the bend, but the same caution should be exercised as when using the hickey on the smaller sizes.

In coming into a switch box where an offset is necessary, it should always be made as in Fig. 3 and not as in Fig. 4. One is made just as quickly and easily as the other. In the former the conduit comes perpendicular to the side of the box so that the bushing and locknut can be drawn up squarely and tightly, making a good mechanical job. Where the conduit comes into the box at an angle, the bushing and locknut can make contact only on their corners with the box and are therefore easily loosened.

In fitting a conduit around an offset in a wall, to get a good fit the bend in the pipe must be made above where the wall changes size. If the bend is made too low, as in Fig. 5, the conduit will not make a good fit and the rigid support obtained for the conduit over the corner of the wall (Fig. 6) is lost. If it is necessary to get section *A* down low, it will require cutting into the corner of the wall for the bend in the conduit.

A conduit cannot be bent around a square corner and make a good fit to the wall. It can be bent as shown in Fig. 7, but this at best is an unsightly job. This brings up the question of using condulets or other fittings to make a good neat job. A comparison of Figs. 7, 8 and 9 clearly shows the advantage of a condulet around a square corner. In Fig. 8 the job is neat and the conduit fits tightly to the wall. Of course, with the arrangement in Fig. 8 the conductors must be pulled-in to the corner and then pulled from here to the next outlet. When putting condulets in the line, care should be exercised to place them so that the wires may be pulled in easily. With the installation shown in Fig. 8, the wires should be pulled from right to left. as indi-

cated by the arrow, since this allows practically a straight pull on the wires. If the wires are to be pulled from the top downward, then the long side of the condulet should be installed as in Fig. 9.

Saddling a beam is a job that cannot be done neatly by bending conduit as shown in Fig. 11. Conduit installed in this way is not only difficult to support rigidly, but it is liable to be struck by objects and knocked loose. Reference to Fig. 10 shows a much better way to do the job. In pulling the wires in, if they can be pulled from the left to *A* or from the right to *B* before the conduit is fastened in place, it will greatly simplify the work. After the wires have been pulled to this point, the conduit can be fastened up into place and the remainder of the installation made around the beam. The sections

FIG. 14. METAL CONDUIT INSTALLED AROUND ELEVATOR CONTROLLER

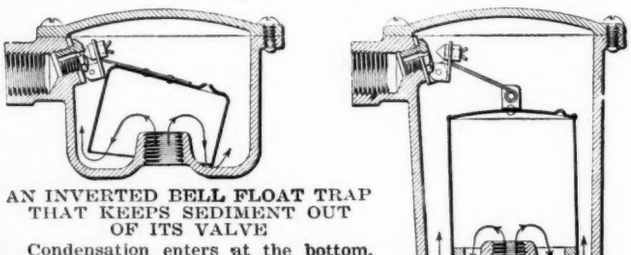
around the beam are short so that the wires can be easily fed from one fitting to the next.

Fig. 14 shows how fittings have been used to run a conduit around an elevator control board. Here a large number of wires are involved, which are brought up through a conduit on each side of the board and out through a number of fittings at the center, as indicated at *A* and *B*. This provides good substantial construction and offers ample protection to the wires where they come out to the connections at the back of the panel.

Where a number of conduits come out of a switch box and bend as in Figs. 12 and 13, it is always best to bend the conduit as in Fig. 13 rather than to use standard 90-deg. bends. It will be observed that the distance between the outlet box and the bends keeps getting longer the greater the number of conduits installed, therefore, each succeeding piece of conduit to make the connection between the box and the bend must be cut longer. These pieces will, in most all cases, require considerable labor, since they require threading on both ends. Another thing, the unions on the bends may in some cases interfere with one another and prevent getting the conduit as close together as when the bends are made. If care is used in making the bends, the only labor in fitting the conduit is that of bending. It is to be noted that the spacing between the conduits at the bends is greater than at other parts, on account of the difference in the radii of the inside and outside of the bend. If equal spacing is desired then, starting from the inside, each succeeding bend must have a longer radius. Whether to use all bends of the same radius or make them having different length radii, there is apparently little choice, excepting that where a larger number of conduits are involved, the outside bends become very large.

Two Armstrong Inverted Bucket Steam Traps

The two steam traps shown in the illustration operate on the same principle, both using an inverted bell float instead of the more usual closed type of float. The inlet is at the bottom, and as long as nothing but liquid is coming through, it follows the course



AN INVERTED BELL FLOAT TRAP THAT KEEPS SEDIMENT OUT OF ITS VALVE

Condensation enters at the bottom, flows up around the float and escapes through the open valve, but steam fills the float, lifts it and closes the valve.

of the arrows, into the float, down around its edges and up around it to the outlet at the top. The valve stays open because the float is in its lower position, and the float stays down because there is water inside it and outside it, so that its weight makes it sink. When steam comes through the inlet, however, it rises directly to the top of the float, thus forcing down the level of the water inside the float. This gradually gives the float enough buoyancy to raise it and close the valve, thus keeping the steam from blowing through the trap. When the steam in the float condenses, the float loses its buoyancy and drops, opening the valve and discharging water until more steam enters. The small hole in the top of the bell float is big enough to let out the air and non-condensable gases that come in with the steam, but the small amount of steam that escapes through it is condensed, being discharged into the surrounding water.

The manufacturers, the Armstrong Machine Works, of Three Rivers, Mich., claim a special advantage in the position of the outlet at the top of the trap, pointing out that oil and grease collect on the surface of the water and are washed out when the valve opens, and that when the valve is closed sediment drops to the bottom, where it does not clog up the valve, but is washed out every time the valve opens.

In the illustration the trap at the left is 3½ in. high, is for pressures from 10 to 150 lb. and will handle the condensation from 435 to 2,496 lin.ft. of 1-in. pipe. The trap at the right is 5½ in. high, for pressures up to 200 lb., and has a capacity for from 456 to 3,978 lin.ft. of 1-in. pipe.

Compounding of Lubricating Oils

By W. F. OSBORNE*

THE desirability of compounding a lubricating oil depends on the service. For steam-engine cylinders and marine-engine lubrication compounding is essential. On the other hand, a pure mineral oil should be used where there is any danger of water causing emulsion.

A HYDROCARBON lubricating oil containing no animal or vegetable component is known as a mineral oil. When an animal or a vegetable oil is added to the oil, the mixture is known as a compounded oil. Mineral oils are compounded principally for the purpose of making them emulsifiable under certain conditions or to raise the viscosity or both.

Compounded Oil in Power Plants

In the power plant the most widely used compounded oil is steam-cylinder oil. There are two kinds of steam-cylinder oils, one a straight mineral oil and one containing compounding. The oils used in compounding steam-cylinder oils are of animal origin, being tallow oil, raw degras (wool grease), prepared degras which is a mixture of raw degras and tallow oil, and sometimes lard oil. Animal oils emulsify when mixed with water and particularly so when mixed with wet steam. A compounded steam-cylinder oil will partly emulsify when introduced into a steam cylinder containing wet steam, and the emulsified oil will adhere to the wet cylinder walls much better than a mineral oil containing no compounding. Such oils will give better lubrication and are more economical under such conditions.

Many years ago it was considered necessary to use straight tallow oil, but it has many disadvantages in addition to its high cost, and has been entirely replaced by the present mixtures of mineral and animal oils. At first only a small amount of mineral oil was added, but the percentage has been gradually increased until now we seldom find a cylinder oil with more than 10 per cent compounding, 5 per cent being the average.

Oils for Marine Service

Another compounded oil which many steam engineers have to use, is marine-engine oil for the lubrication of reciprocating marine steam engines. Such oils are compounded with a vegetable oil, blown rapeseed oil, the percentage of compounding varying from 10 to 20, depending upon the requirements of the engine. Owing to the mechanical construction of these bearings, heavy loads per square inch and high temperatures, it is frequently considered necessary to allow a small stream of water to flow over the bearing to keep it cool. A straight mineral oil would be quickly washed out of the bearing under such conditions, but the compounded oil is emulsified by the water, producing a lather that sticks to the metal surface and gives lubrication. The high viscosity of the blown rapeseed oil also raises the viscosity of the mineral oil, particularly at high temperatures, which is quite an advantage for marine service where speeds are low and pressures are high. The nature of the bearing service prevents the formation of a perfect lubricating film, and the heavy-bodied compounded oil serves to lubricate better than a mineral oil.

Another place where a vegetable oil is used to raise the viscosity of a mineral oil is in airplane engines. These oils consist of a heavy-bodied mineral oil compounded with castor oil in varying percentages. Sometimes the castor oil is used straight without any mineral oil whatever.

Emulsions with Compounded Oil

There is one thing to remember about compounded oils. Do not use them on any equipment where an emulsion will be dangerous or undesirable. Furthermore, on account of their cost and the possibility of trouble when they are not handled properly, it is never advisable to use them anywhere unless a straight mineral oil cannot be made to do as good work. The steam cylinder is one place where the compounded oil is absolutely essential for efficient and economical lubrication.

Compounding, or the presence of animal or vegetable oils, is detected by chemical means, a tentative method having been worked out by the A. S. T. M., which should be followed by those who have suitable laboratory equipment available. For the power-plant engineer the formation of a "lather" or emulsion can sometimes be used as an indication of compounding, although the emulsion may also be caused by a straight mineral oil under certain conditions.

Tallow oil, degras, blown rapeseed oil and lard oil can usually be detected by their characteristic odors, but of course the percentage present can be determined only by accurate laboratory methods.

Acids in Oils

Since all fatty oils used for compounding contain free fatty acids, a very important test in this connection is the acidity test. This in turn is another test that can be made only in the laboratory. The litmus-paper test frequently used by some engineers is not a true indication of the presence or absence of acid as the acids may not be soluble in water, which is necessary for the litmus-paper test to be effective, or the water used in connection with the test may be so alkaline that it will neutralize the effect of the acid.

The danger from acids in any oil depends on the character of the acid as well as upon the amount. Mineral acids such as sulphuric and hydrochloric are very active in the presence of moisture, and if they are contained in the oil, even in slight amount, trouble will certainly follow when the oil is put into service. The utmost care is used by all reputable refiners to prevent any trace of acid appearing in any oil placed on the market, and the engineer can feel quite safe in this respect when purchasing from any of the well-known refiners.

The fatty acids contained in animal and vegetable oils are comparatively inactive with respect to metals and, when the oil contains no moisture, are perfectly harmless so far as their effect on metals is concerned. They do, however, cause emulsions, sludges and deposits, when mixed with water and subjected to heat, and are very undesirable where any of these things might cause

*Supervisor Manufacturers' Service, Texas Co.

trouble. The fatty acids in the presence of moisture will sometimes induce corrosion of metal parts, and on this account it is desirable that the acidity be kept at a minimum. This effect of corrosion is not experienced when the proportion of water is large, as may be seen from the anti-rust properties of soluble cutting oils, all of which contain fatty acids.

Straight mineral oils will almost always develop acidity when subjected to high temperatures in the presence of moisture and air. This acidity is caused by the formation of petroleum acids and seldom does any harm other than to increase the tendency of the oil to emulsify. An oil used in a circulating system, for instance, will increase in acidity, and in time the oil will develop a condition that will cause emulsions if an excessive amount of water gets into the system.

Greases will practically always show some acidity on test, but unless moisture enters the bearing, no corrosion will occur even though the acidity be as high as 5 per cent. It must be remembered that the activity of such acids as these is very slight as compared with the action of the mineral acids.

Q. What is the maximum acidity that should be allowed in the following oils when new? Mineral oil; steam-cylinder oil; marine-engine oil.

A. Mineral oil, 0.10 per cent; steam-cylinder oil, 0.50 per cent; marine-engine oil, 2 per cent.

Q. What is the maximum allowable acidity for a suitable grease for bearing lubrication?

A. For ordinary sleeve bearings, 0.50 per cent; for ball and roller bearings 0.20 per cent.

Young Motor-Pump Set Holds Vacuum Automatically

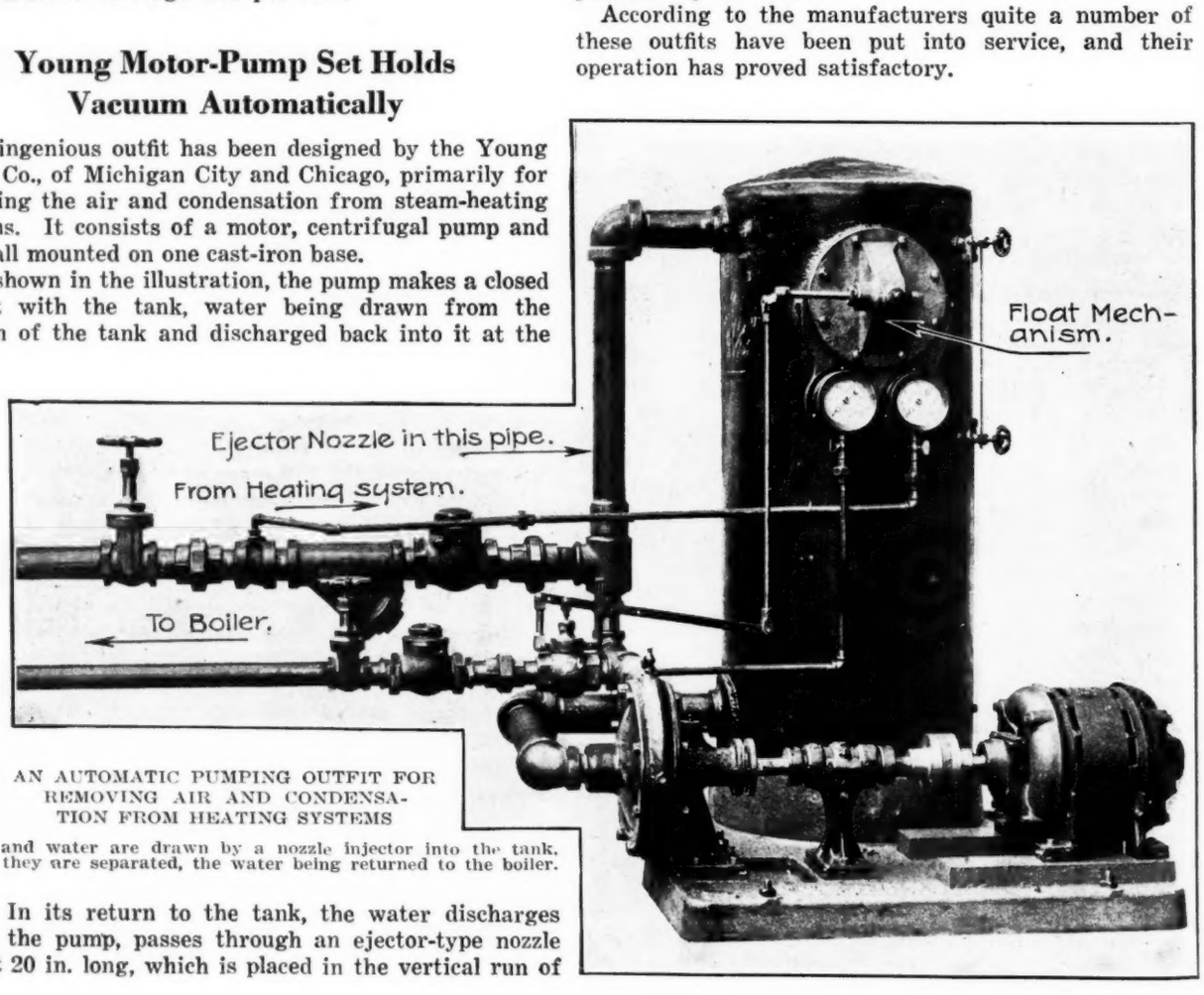
An ingenious outfit has been designed by the Young Pump Co., of Michigan City and Chicago, primarily for removing the air and condensation from steam-heating systems. It consists of a motor, centrifugal pump and tank, all mounted on one cast-iron base.

As shown in the illustration, the pump makes a closed circuit with the tank, water being drawn from the bottom of the tank and discharged back into it at the top. In its return to the tank, the water discharges from the pump, passes through an ejector-type nozzle about 20 in. long, which is placed in the vertical run of pipe, and thus makes a suction on the return line, drawing the air and condensation into the tank. Here the air is separated from the water and passes to the atmosphere through a vent pipe at the top of the tank. As the level of the water of condensation rises in the tank, it raises a copper float which, in turn, opens a balanced bypass valve on the discharge side of the pump, so that the excess water is automatically forced into the boiler, heater or other receptacle. As shown, a suction strainer, a check and a gate valve are placed in the return line from the system, and a check and a gate valve in the supply line to the heater or boiler.

If required, an automatic vacuum control is provided. The outfit will run until the vacuum has reached 9 to 10 in., when the motor is automatically cut out and stands idle until the vacuum has dropped to 3 to 4 in. At this point the motor is automatically started and runs until the vacuum has reached the higher limit of 10 in. of vacuum. This vacuum is guaranteed when the system is tight and the temperature of the returns is not over 180 deg. F. On a closed system the ejector has pulled as high as 28 in. of vacuum.

The outfit is made in six sizes, with capacities from 5,000 to 65,000 sq.ft. of radiation, water capacities from 12 to 105 gal. per min. and motor horsepower from 1 to 7½ hp. Standard sets are made to carry 20 lb. pressure on the pump and will discharge against this pressure in the boiler, less the friction in the discharge line and the difference in levels between the pump discharge and the water in the boiler. Special outfits are built for any pressure up to 50 lb.

According to the manufacturers quite a number of these outfits have been put into service, and their operation has proved satisfactory.



AN AUTOMATIC PUMPING OUTFIT FOR REMOVING AIR AND CONDENSATION FROM HEATING SYSTEMS

Air and water are drawn by a nozzle injector into the tank, where they are separated, the water being returned to the boiler.

Size of Cutouts for Protecting Motor Circuits

Examples Showing How To Determine the Size of Fuses for Motor Circuits To Comply with National Electrical Code Rules

By EDGAR P. SLACK
Assistant Electrical Engineer, Underwriters Laboratories

WIRES of motor circuits, under the National Electrical Code rules, "must be protected in accordance with the general requirements for the protection of conductors; that is, the rated capacity of the fuses must not exceed the carrying capacity of the conductors, and circuit breakers must not be set more than 30 per cent above the carrying capacity of the conductors, as given in No. 18." The carrying capacities referred to are given in Rule 18 of the Code and are reproduced in the accompanying wire table.

To get a clear idea of this requirement, suppose the line is run with 200,000-circ.mil rubber-covered cable, which, according to column *A* in the table, is rated 200 amperes. This conductor might be protected by a fuse or, if under the supervision of a skilled attendant, by a circuit breaker. If a fuse were used, the 200-ampere size would be chosen, larger sizes being prohibited by the rule. Such a fuse, according to standard ratings, would carry 220 amperes indefinitely and probably would carry 250 amperes for a considerable time. At 300 amperes it would open within six minutes and would blow at once on a short-circuit. If an automatic circuit breaker were used, it could be set up to 30 per cent above 200, or 260 amperes. Such a breaker, if of the ordinary instantaneous type, would not operate below 260 amperes, but would open the circuit at this current.

This rule is designed to protect the conductors against excessive heating or mechanical stresses which might be caused by short-circuits and also against deterioration of the insulation resulting from heavy, long-continued overloads. At the same time either the fuse or the circuit breaker allows a moderate overloading of the conductor, the Code recognizing that certain overloads cannot be avoided in practical work, and that provided they are not excessive, their effect on the conductor can be disregarded.

There is one exception to the general rule quoted in the foregoing, and this deals with alternating-current motors such as the squirrel-cage type, which require a large starting current. "Where rubber-covered wire is used in a branch circuit carrying the current of only one alternating-current motor of a type having large starting current and this circuit is protected by fuses, it may be protected in accordance with Table C of No. 18." (This reads "Table B" in the 1920 Code through a misprint.)

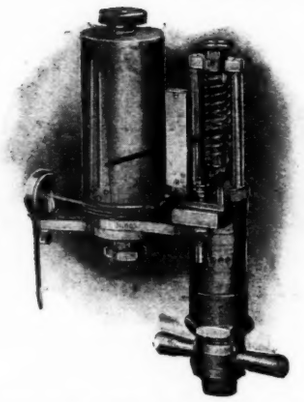
Take for example the case of a squirrel-cage motor rated 45 amperes, to be started with an auto-starter. First, the size of wire has to be determined. The general Code rule is that the line must have a capacity at least 110 per cent of the motor rating. For squirrel-cage motors a larger-capacity wire is recommended, in this case 200 per cent of the rated value, or 90 amperes. Assuming rubber-covered wire to be employed, as usual, reference to column *A*, in the table of carrying capacities, shows that for 90 amperes a No. 2 B. & S. gage conductor is required. Under the foregoing exception, the No. 2 wire, although rubber-covered, may be fused in accordance with column *C* of carrying capacities; that is, with 125-ampere fuses. The reason for making this allowance, which on the average represents an increase of about 50 per cent in the fuse size, is that the inrush of starting current is of such short duration that the heating produced in the No. 2 conductor would not be enough to injure the insulation. With this type of machine the starting current may be several times full-load current and would be almost certain to blow a 90-ampere fuse on the No. 2 conductor.

As previously noted, the smallest capacity of line permitted for this motor in any case would be 110 per cent of 45, or about 50 amperes. This calls for at least a No. 6 conductor, under column *A*, which could be fused up to 70 amperes under column *C*. Suppose the conditions were so special that a 70-ampere fuse would not blow on starting; it would then be possible to use a No. 6 wire with 70-ampere fuses and still comply with the rule. But suppose this 45-ampere motor were so exceptionally designed that a 50-ampere fuse would not blow on starting. It might then be argued that since under column *C* a 50-ampere rating corresponds with No. 8 B. & S. gage, a No. 8 rubber-covered wire ought to be sufficient. This is not the case; a No. 8 wire is rated at only 35 amperes, column *A*; and a No. 6, as computed in the foregoing, is the smallest size allowed in any case. In order to cover this point and leave no room for doubt, the rule goes on to say that "in no case should a rubber-covered conductor in a branch circuit carrying the current of only one motor have a carrying capacity in accordance with column *A* less than 110 per cent of the name-plate current rating of the motor."

ALLOWABLE CARRYING CAPACITIES OF COPPER WIRES AS SPECIFIED BY THE NATIONAL BOARD OF FIRE UNDERWRITERS

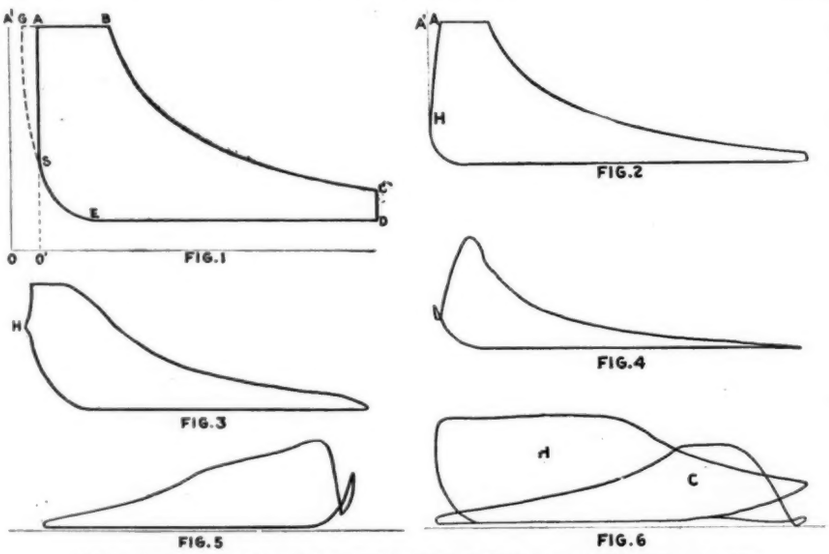
B.&S. Gage	Diameter of Solid Wires in Mils	Area in Circular Mils	A Rubber Insulation Amperes	B Varnished Cloth Insulation Amperes	C Other Insulation Amperes
18	40.3	1,624	3	....	5
16	50.8	2,583	6	....	10
14	64.1	4,107	15	18	20
12	80.8	6,530	20	25	25
10	101.9	10,380	25	30	30
8	128.5	16,510	35	40	50
6	162.0	26,250	50	60	70
5	181.9	33,100	55	65	80
4	204.3	41,740	70	85	90
3	229.4	52,630	80	95	100
2	257.6	66,370	90	110	125
1	289.3	83,690	100	120	150
0	325.0	105,500	125	150	200
00	364.8	133,100	150	180	225
000	409.6	167,800	175	210	275
....	....	200,000	200	240	300
0000	460.0	211,600	225	270	325
....	....	250,000	250	300	350
		300,000	275	330	400
		350,000	300	360	450
		400,000	325	390	500
		500,000	400	480	600
		600,000	450	540	680
		700,000	500	600	760
		800,000	550	660	840
		900,000	600	720	920
		1,000,000	650	780	1,000
		1,100,000	690	830	1,080
		1,200,000	730	880	1,150
		1,300,000	770	920	1,220
		1,400,000	810	970	1,290
		1,500,000	850	1,020	1,360
		1,600,000	890	1,070	1,430
		1,700,000	930	1,120	1,490
		1,800,000	970	1,160	1,550
		1,900,000	1,010	1,210	1,610
		2,000,000	1,050	1,260	1,670

Reasons for Distorted Admission Lines on Indicator Diagrams



This Article Discusses the Subject of Lead and by Typical Diagrams Shows the Engineer the Manner of Admission Line to Avoid

BEFORE the end of the back-pressure stroke the closing of the exhaust valve traps in a certain amount of the back-pressure steam as outlined in the discussion of the compression line in the last article. This steam is compressed by the piston and at the end of the stroke fills the clearance volume at a pressure of *O'S*, Fig. 1. The opening of the steam valve admits high-pressure steam into the clearance space, and the steam already in the clearance at the pressure *O'S* is compressed by the high-pressure steam coming from the boiler until the clearance pressure rises to *A*. The piston reverses and starts on its forward stroke while the boiler is pouring steam in at this pressure. It is essential that the steam valve opens promptly when the piston has reached its dead-center point. In fact, since there is a slight lag in the flow of steam when the valve first opens, the latter should open slightly before dead center.



FIGS. 1 TO 6. DIAGRAMS SHOWING TYPICAL ADMISSION LINES

Fig. 1—Ideal admission line. Fig. 2—Corliss diagram showing late admission. Fig. 3—Late admission in a four-valve engine. Fig. 4—Late admission caused loop. Fig. 5—Late admission in a slide valve engine. Fig. 6—Example of poor valve setting.

With a correct point of valve opening or admission, the cylinder pressure rises immediately to the steam chest pressure as shown in Fig. 1. The piston at this point is not moving, and the supply of live steam needed to fill the volume *GA* is comparatively small.

A vertical admission, such as in Fig. 1, is found in diagrams from slow- or medium-speed engines having a quick-opening admission valve. High-speed engines, even of the four-valve type, as a rule do not have this ideal line, for the slightest misadjustment or wear of the valve mechanism will alter the exact time of valve opening.

When setting valves, if the engineer does not take into account the tendency of the steam to lag a little when the valve first opens, the admission will be late; that is giving the appearance of negative lead. A diagram taken from a Corliss engine and showing late admission appears in Fig. 2. The piston had already moved from the dead-center point the distance *A'A* before the opening of the steam valve enabled the boiler to fill the space between the cylinder head and piston face with steam at boiler pressure. Although the same amount of steam is used per stroke, the diagram area *A'HA* has been lost. Late admission appears in the diagram Fig. 3 from a non-releasing Corliss. The compression reached the point *H* and the piston had just reversed when the steam valve opened. The short connecting rod, together with the high relative speed, caused the piston to travel ahead of the steam entering through the partly opened valve until the full opening of the valve was reached, whereupon the pressure rose to that of the steam chest. Frequently, admission is so late that the clearance steam starts to re-expand, giving the loop in Fig. 4, which was from a Corliss engine with a badly deranged valve setting.

This loop is by no means uncommon and is found on many slide-valve engines. Fig. 5 reveals a decidedly late admission, and inspection will show that the cutoff, release and compression are all late. It was found that the eccentric had slipped on the shaft.

In Fig. 6 the crank-end diagram has a very late admission, while on the head end the admission is correct but cutoff and release are late. This is a result of having set the eccentric back, making all the events take place considerably after their proper time. The engineer then tried to correct the trouble by altering the length of the valve rod and brought the head-end admission back to approximately the correct point, as shown. By shortening the valve rod, the head-end steam lap was decreased, but this at the same time acted to increase the head-end exhaust lap, to decrease the crank-end exhaust lap and to increase the crank-end steam lap. The adjustment made the head-end admission correct, the head-end cutoff and release late and the com-

pression early, while the crank-end lead became negative, making the crank-end admission very late and the cutoff early, while the release and compression were late as shown.

To adjust the valves properly, the eccentric should have been made set ahead and the valve-rod length altered to give equal leads on both ends.

Still another instance of late admission appears in Fig. 7. This diagram was from an 18 x 18 throttle-governed slide-valve engine. It was found that the eccentric had slipped so that the admission took place when the piston was 4½ in. past dead center.

In Fig. 8 the diagrams are from the high-pressure cylinder of a compound Corliss engine. Both head- and crank-end diagrams show a slight curve at the beginning of the steam line. This is caused by the eccentric being set late, causing a slight wiredrawing as the valve opens. The release is late on both diagrams. The back-pressure line follows the expansion line for a time, showing that release took place after the piston had reversed. By setting the eccentric ahead of the present position, the valves would function properly. It has been pointed out that objectionably early admission is not so common as late admission, although by no means unusual. In Fig. 9 the diagrams, which are from a non-releasing four-valve engine, show the admission line *HA* sloping toward the diagram end, indicating very early lead. Early admission does not decrease the diagram area to any extent, but is objectionable because it is adding to the load on the piston before reversal.

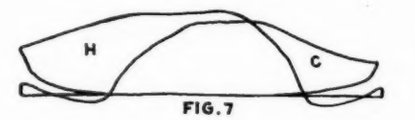


FIG. 7

FIG. 8

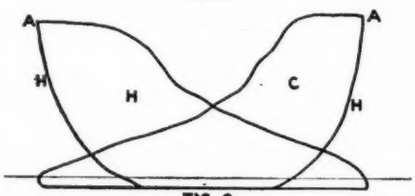


FIG. 9

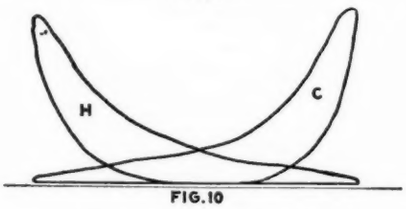


FIG. 10

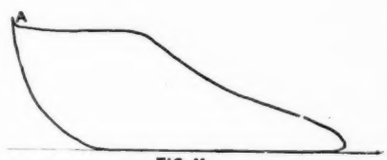


FIG. 11

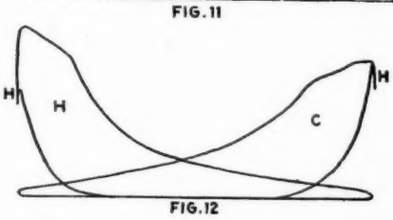


FIG. 12

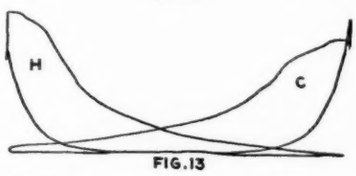


FIG. 13

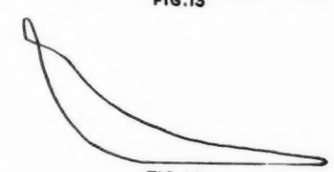


FIG. 14

FIGS. 7 TO 14. DIAGRAMS WITH UNUSUAL ADMISSION LINES

Fig. 7—Results of a slipped eccentric. Fig. 8—Wire-drawing at admission. Fig. 9—Early admission. Fig. 10—Early admission in a unaflow engine. Fig. 11—Peak caused by high compression. Fig. 12—High compression and late admission. Fig. 13—Effect when admission is later than in Fig. 12. Fig. 14—Admission in high speed engine on light loads.

Fig. 10 shows diagrams of a unaflow engine. In these there is excessive lead which was caused by adjusting the steam-valve cams with too close a clearance, the cam then contacting with the valve stem slightly before dead center.

In many diagrams a vertical line appears at *A*, Fig. 11. This line may be due to compression being carried above the boiler pressure. In the majority of instances it is the result of the momentum of the pencil motion or the piston spring of the indicator. The pencil tends to continue its vertical movement beyond the height corresponding to the existing pressure. By using a stiffer spring and pressing lightly on the pencil lever with one finger, the peak *A* will usually disappear. At times, however, the peak is the result of compression above boiler pressure, combined with admission slightly delayed.

Engineers are often puzzled by a vertical drop in the pressure line at the beginning of the stroke, as at *H*, Fig. 12. This is almost always caused by carrying the compression fairly high, combined with late admission. Making the admission still later will give the admission line the appearance shown on the crank-end diagram in Fig. 13, where the effect of the late admission is evident.

High-speed single-valve engines on light loads have early compression, carrying the compression line above boiler pressure. The diagram in Fig. 14 results.

High-speed single-valve engines are usually controlled by a shaft governor. With the governor design almost always used, the eccentric swings across the shaft, changing the angle of advance and the eccentricity with any change in load. On light loads the cutoff is made early by reason of both the increased angle of advance and the decreased eccentricity. Compression is made earlier by the increased angle of advance and shorter valve travel. Admission is made later by the decreased travel and earlier by the increased angular advance, the net result being a later admission. Compression on very light loads may start so early as to cause the pressure to rise much above boiler pressure before the travel of the valve causes admission. A loop as in Fig. 14 then results. It is impossible to correct this without altering the valve or governor design, and since it occurs only on light loads, it is not of great effect unless the engine habitually runs with low loads.

Admission in four-valve non-releasing gear engines should take place at dead center, giving a diagram similar to Fig. 12 without the line at *H*.

Secretary of Commerce Hoover recently appeared before the Senate Appropriations Committee to advocate funds for the Bureau of Standards to carry on engine tests, saying that the efficiency of gas engines does not run above 30 or 40 per cent of that possible. He believes an investigation of accuracy of mixtures, carburetors, etc., will result in suggestions to raise the efficiency of engines considerably.

A Simple Test for Measuring Surface-Condenser Leakage

By O. P. ADAMS and PAUL F. HOOTS*

WHEN measuring the volume of the condensate in order to determine the water rate of a steam turbine equipped with a surface condenser, it is necessary that the percentage leakage of the condenser be exactly known. Although there are several methods of determining this leakage, the following will probably give more accurate results than can be obtained by the use of any of the others.

For the determination of the leakage by this method, it is necessary to take samples of the hotwell returns and cooling water and to condense a sample of the turbine steam supply. These samples are taken during the entire test and are later to be analyzed for their content of chlorine. In the event that sealing water is required for the hotwell pump, the condensate from the condenser must be used for the purpose.

Samples of equal size are taken at regular intervals of time from the discharge of the hotwell, these samples being mixed into one large composite sample. Samples of the cooling water are taken in the same manner and at the same intervals of time. As it is possible for a certain amount of chlorides to be carried over with the steam, this quantity must be determined. To obtain the sample, a small valve on the steam line is connected to a long copper condensing coil which is kept covered with cracked ice in a bucket. By barely "cracking" the valve, a small quantity of steam is continually condensed during the test.

> Tests of the sort herein described are usually carried out by chemists rather than engineers, because a certain amount of chemical manipulation is required. However, there is no reason why they should not be made by an engineer, provided he can get the few pieces of apparatus that are needed and can obtain, from some chemist, the standard solutions made up ready to use.

Great care should be exercised in taking these samples. The containers used must be well rinsed several times with the waters to be taken, before retaining any for the final sample. To avoid contamination from outside sources, these containers should be kept covered.

It is evident that if the chlorine content of each of the samples can be determined, the leakage of the condenser can be calculated, since any increase in chlorine content of the condensate over that in the steam must come from the cooling water. The method of making the calculation will be explained later. The chemical procedure in analyzing the samples is as follows:

Before the analysis can conveniently be carried out, it will be necessary to take accurately measured portions of the three samples and evaporate them down to a volume of approximately 35 c.c. each. In the case of the condensate from the steam line it will be necessary to start with about 1,000 c.c., because the chlorine content of this water will be low. For the hotwell discharge and the cooling water the size of the original samples required can be determined by a preliminary test. It is merely a question of getting a sample large enough to contain an easily measured quantity of chlorides.

While it is necessary that the size of the three samples finally taken for evaporation be accurately known, their size after evaporation needs to be only approximately 35 c.c., since evaporating down does not change the total weight of chlorides in solution. If any of the samples are turbid, they should be filtered. In the event that any are alkaline to a phenolphthalein solution, they are neutralized by running in a few drops of tenth-normal sulphuric acid until the color changes.[1]

In case the engineer does not have a chemical laboratory available, it is best to obtain these solutions as well as those mentioned later, from a chemist, who can also give some helpful hints as to their use.

Each of the three samples is placed in a 4-in. porcelain casserole[2] together with 1 c.c. of a potassium-chromate solution (for an indicator) having a strength of 50 grams per liter. The samples are now "titrated" with a solution of silver nitrate containing 2.396 grams per liter.

For the benefit of readers who are not acquainted with chemical processes, the following explanation of what is meant by "titrating" with the silver-nitrate solution may be helpful. A burette (a tall graduated tube with a cock at the bottom) is nearly filled with the nitrate solution. After the position of the nitrate has been read, it is allowed to run, drop by drop, into the vessel that contains the sample. The sample is continuously stirred. The instant the first reddish tint appears, and persists on stirring, the cock is closed and the graduation on the burette is read. The difference between the two readings gives the volume of nitrate solution required to precipitate the chlorides in the sample.

The strength of the silver-nitrate solution mentioned is such that every cubic centimeter of it used in titration represents approximately 0.0005 gram of chlorine in the water. A slight variation in the strength of the silver-nitrate solution from that given will make no difference in the final result, since it is the relative amount of chlorine in the three samples, rather than the actual amount, that is important.[3]

All the samples must be titrated under exactly the same conditions and to the same end point, the first change of color being accepted as the end point. The number of cubic centimeters of silver nitrate required to precipitate the chlorides in 1,000 c.c. of each of the waters is now calculated. For example, if 4.2 c.c. of the silver-nitrate solution were required to titrate a sample that has been boiled down from 300 c.c. the re-

*New Orleans Railway & Light Co.

[1] Add a few drops of phenolphthalein indicator to the sample. If the solution turns pink, it shows the presence of what is known as mono-carbonate or caustic alkalinity. Neutralize this by running in the tenth-normal sulphuric acid drop by drop while stirring the sample. Stop when the color just disappears.

[2] The word "casserole," as used by chemists, means a bowl-shaped vessel with handle attached. For chlorine titrations a porcelain casserole is particularly useful, since the end point is more easily noted in a white vessel.

[3] If desired, however, the silver nitrate solution may be accurately standardized with a standard solution of sodium chloride.

quired figure would be obtained as follows: $4.2 \times \frac{1,000}{300}$ = 14.0 c.c. of silver nitrate per 1,000 c.c. of original sample. The actual percentage of leakage is obtained from the formula,

$$X = \frac{100\ (b - a)}{c - a}$$

In this formula X is percentage of leakage. The number of cubic centimeters of silver nitrate required to precipitate the chlorides in 1,000 c.c. of original sample is represented by: a, for the condensate from the steam line; b, for the hotwell discharge water; c, for the cooling water.

This method has been satisfactorily used for the determination of small leakages even when the chlorine content of the cooling water was extremely low.

Diel-More Valve Drains Cylinders Automatically

A relief valve for use with all kinds of reciprocating steam equipment, which automatically drains the cylinder when the throttle is closed, is shown in Fig. 1. The object of the device is to make it unnecessary for the engineer to bother with opening and closing the cylinder drain valves and to make for greater safety.

The drain pipes from the two ends of the cylinder are brought down just below the cylinder and connected to the valve body at both sides, as shown in Fig. 1. There being no valves in these pipes, the full steam pressure carried in the engine cylinder is let into the valve chamber, tending to lift the valve disc. However, the

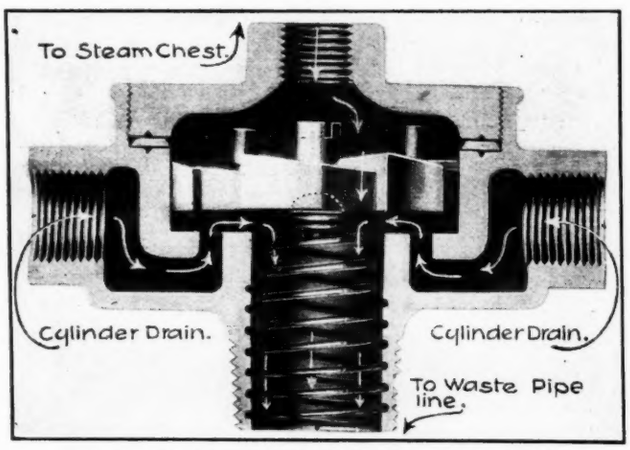


FIG. 1. AN AUTOMATIC CYLINDER DRAIN AND RELIEF VALVE

With the engine running, full throttle pressure holds the disc down against the cylinder pressure under it; with the throttle closed and the engine idle, the spring raises the valve disc, draining the cylinder. Any water that enters the cylinder while the engine is running forces the valve open and escapes.

disc will not be raised by this pressure if the engine throttle is open, because the full steam pressure at the throttle is holding it down. This full steam pressure is let in through the top opening, to which a pipe from the steam chest is connected. The pressure in the steam chest is, of course, a little greater than that in the engine cylinder, and so the valve stays closed while the engine is running.

When the throttle is closed and the engine is stopped, however, the valve disc no longer has more than atmospheric pressure above it, and so is raised by the spring beneath it. This leaves a free passageway from the two ends of the cylinder into the drain pipe, so that water runs out of the cylinder as fast as it condenses. When the throttle is opened later to start the engine again, the cylinder is already free of condensation, and the drain valve is closed by the steam pressure in the valve chest.

The top of the valve disc is so shaped as to give a sort of turbine action, the pressure of the steam tending to turn it. Since it is connected with its spring by a joint that leaves it free to turn, it is given a slight twist every time it is closed, and so may be said to be self-grinding. On the circumference of the disk are eight shallow grooves, as shown in Fig. 1, so that condensation from the steam chest can escape into the main drain, together with that from the cylinder itself.

FIG. 2. WHISTLE DRAIN

The spring that holds the valve disk off its seat may be easily adjusted for tension by screwing it in or out, a helical groove being cut on the inside of the pipe to correspond with the turns of the spring. The device may act not only as a drain valve, but also as a relief valve, in this way: If water comes into the cylinder while the engine is running, the piston will force it through the drain pipe into the relief valve and up against the bottom of the valve disk; as the pressure under the disk will then be temporarily greater than over it, the disk will rise and let the water out. Of course, a large slug of water would scarcely pass through the small drain pipe fast enough to avoid wrecking the engine, but a certain amount of water could doubtless be handled by the valve in this way, and so partly, at least, protect the engine.

Another use of the device is with direct-connected engines, as locomotives. In such cases, when the engine is idling the valve disc is kept off its seat by the spring, there being no pressure over it, and hot air is drawn back and forth between the two ends of the cylinder. This avoids warping of the cylinder, which is otherwise likely to be caused by the cold drafts of air that are drawn in at every stroke through the usual type of drain cock.

By the addition of two extra drain inlets in the valve body, making four in all, the valve is made suitable for use on duplex pumps.

The smaller valve in Fig. 2 works on much the same principle, and is applied to whistles and similar devices that may give trouble with condensation. The spring holds the valve open until steam is turned on, when the pressure closes it.

Both valves are distributed in the United States by the Diel-More Sales Co., Inc., Bourse Bldg., Philadelphia, Pennsylvania.

In a coal-fired boiler about 65 per cent of the total evaporation is due to the radiant heat and 35 per cent to heat worked out of the gases by convection. In a waste-heat boiler the heat transferred will be about 93 per cent by convection and 7 per cent by radiation. Therefore, the rate of heat transferred by convection in a waste-heat boiler will be about 2.7 times that in a direct-fired boiler.

Using Exhaust Velocity To Reduce Back Pressure in Steam Engine

PROF. STUMPF and his associates, in designing a unaflow locomotive, have been able, by a modification of the exhaust ports and piping, to reduce the back pressure on the cylinder. This allows them to employ a smaller clearance volume without danger of a high final compression pressure when operating non-condensing. Other advantages peculiar to the locomotive, such as a more uniform blast draft, which will not be considered here, are also secured.

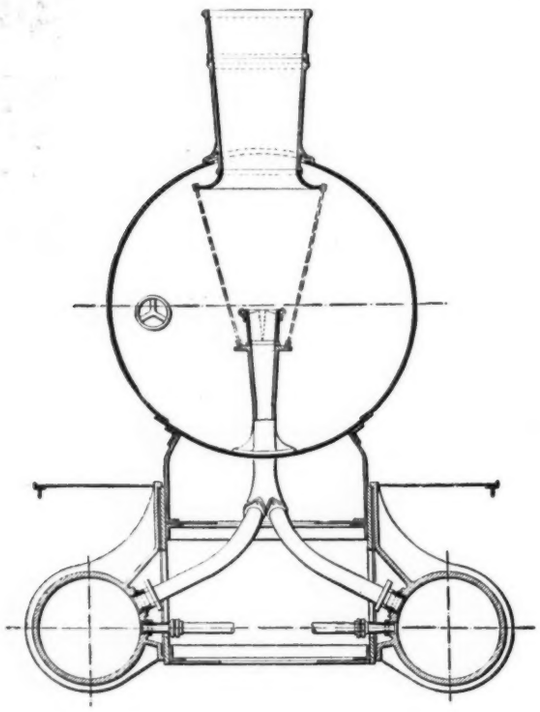


FIG. 1. UNAFLOW LOCOMOTIVE EXHAUST NOZZLE

If the exhaust lead or point of release is increased to 20 to 25 per cent, the large number of exhaust ports of small width customary in the unaflow cylinder may be replaced by a single port or valve of greater width. This port may be given the profile of a nozzle and so formed that for even part opening a fairly good nozzle effect is obtained. This nozzle is inserted in the cylinder wall at about 60 deg. from the vertical and has its continuation in the smooth exhaust line ending in the blast nozzle. The cross-sections of the piping at all points have been carefully calculated to conform to the theory of the ejector.

The exhaust from one end of the cylinder, in passing through the nozzle and pipe, has its pressure energy converted into kinetic energy. This results in a low pressure existing in the exhaust line when the exhaust port of the second cylinder is uncovered.

An indicator diagram is shown in Fig. 2 in which the pressure scale has been enlarged to three times normal, equivalent to using a light spring. This shows very clearly the partial vacuum of approximately 4.4 lb. (.68 atmos.). This low back pressure and the single-beat poppet valves used allow a reduction in clearance volume from 17 to 12 per cent.

The pressure energy of the toe *A* and *B* of the diagram, Fig. 3, is converted into velocity energy by the nozzles. The velocity is diminished during the periods of overlapping exhaust, when steam of high and low velocity meet, with the final result that a more or less continuous stream is produced.

Viewed from stationary engine operation, this nozzle effect lowers the compression line, giving the increased area *C* to the indicator diagram. This gain is in part offset by the loss of the area *EGF*, Fig. 4, the area being the loss occasioned by releasing at *E* instead of at *F* as usual. It is apparent that there is a real thermal gain as well as a mechanical advantage of increased clearance and low compression pressures. The steel-mill and paper-mill duplex engine should be able to use this device with advantage.

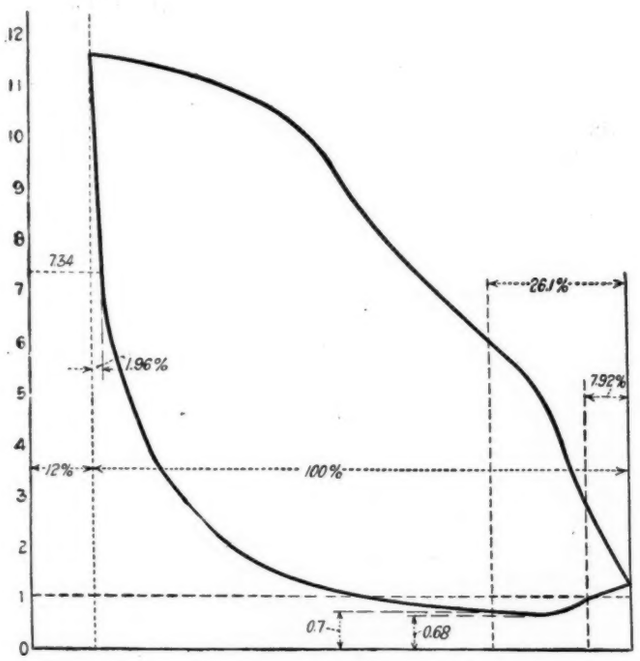


FIG. 2. UNAFLOW INDICATOR DIAGRAM

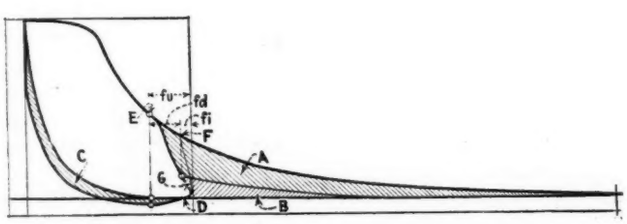


FIG. 3. GAIN DUE TO NOZZLE EFFECT

A 50 per cent addition to the capacity of the Northeast Plant of the Kansas City Power and Light Co. is now under way. There are at present three units of a total capacity of 60,000 kva., and there is being added a 30,000-kva. unit and four boilers having 12,500 sq.ft. of heating surface each.

A Boiler-Room Slide Rule

It is often convenient to be able to make a quick approximate estimate of boiler economy from measurements of CO_2 and flue temperature. The accompanying illustrations show the operation of the Fuel-Combustion Calculator, a special slide rule designed for boiler-room use. This Calculator, which is made of hardwood and has a celluloid runner, is the joint invention of Stephen H. Payne[1] and Huylett O'Neill.

The illustrations show the settings required for finding the following quantities: (1) Boiler efficiency; (2) equivalent evaporation per pound of fuel; (3) fuel cost per thousand pounds equivalent evaporation; (4) pounds of air supplied per pound of combustible.

It is assumed that the following data have been obtained: Heat value of coal, 14,500 B t.u. per lb.; CO_2, 15 per cent; flue temperature, 700 deg. F.; fuel cost, $5 per ton of 2,240 pounds.

The method of obtaining the answers is as follows: First (turning to Fig. 1) move the slide until the intersection of the curve for 15 per cent CO_2 and the line for 700-deg. flue temperature is directly over 14,500 B.t.u. on the lower scale. This is easily done with the celluloid "runner," which has a vertical scratch in the center. The per cent efficiency (75.7) is found on the bottom scale of the slide directly above the index *E* at the left end of the lower stationary scale. The settings in this and the following problems are indicated by arrows and dotted circles.

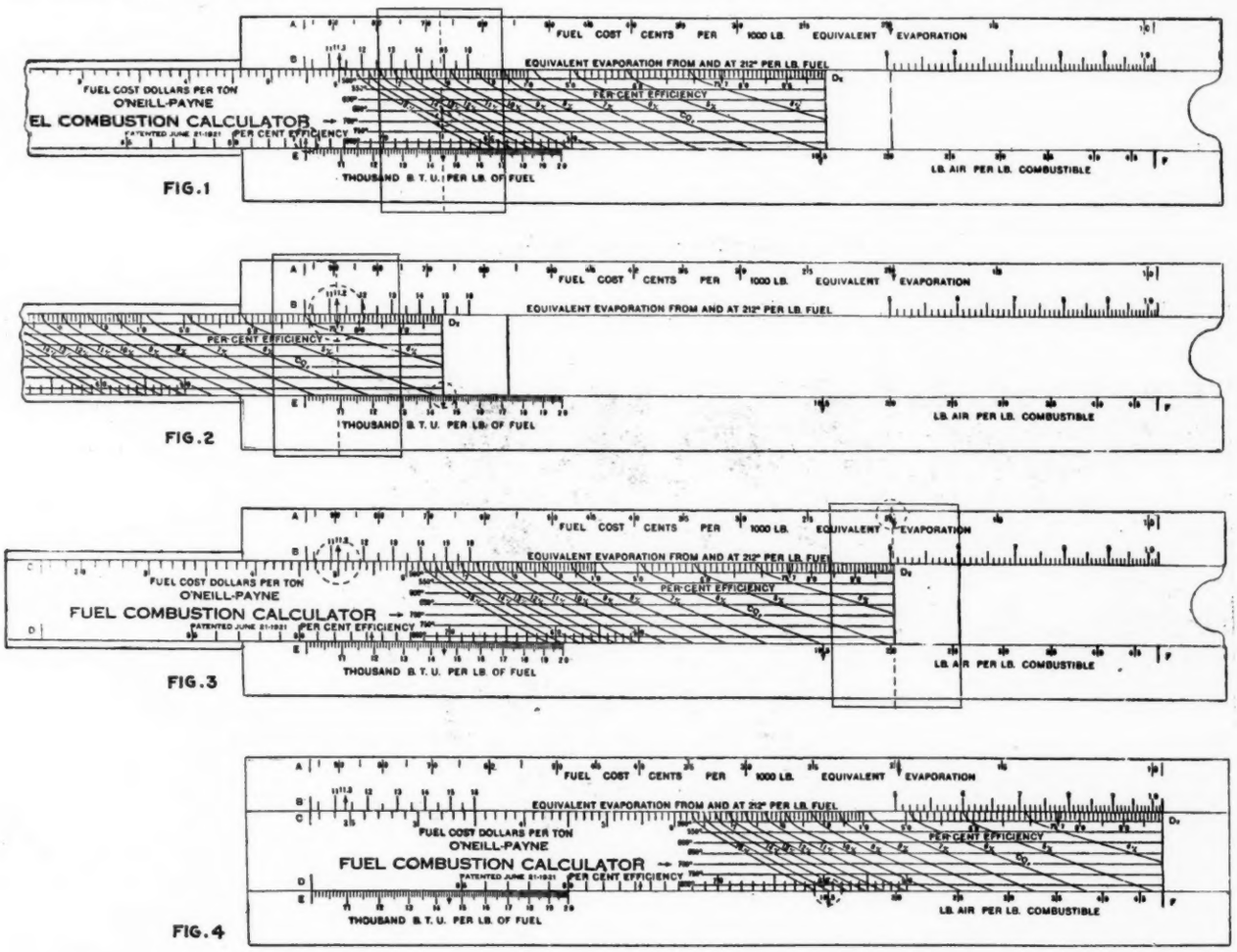
Fig. 2 shows the settings for getting the equivalent evaporation (from and at 212 deg. F.) per pound of fuel. The slide is moved until the right index (end) of its scale is at 14,500 B.t.u. on the lower stationary scale. Then the runner is moved to 75.7 per cent efficiency on the upper scale of the slide. Directly above it is found the answer, 11.2 lb. equivalent evaporation per pound of coal.

Fig. 3 shows how to get the fuel cost per 1,000 lb. equivalent evaporation. The first step is to move the slide until 5 on the "fuel cost, dollars per ton" scale of the slide is just below 11.2 on the "equivalent evaporation" scale. Then move the runner to the right index of the slide. Above it on the top edge of the topmost scale read the answer: 19.6 cents, the fuel cost per 1,000 lb. equivalent evaporation.

To find the air used per pound of combustible, move the slide to the position shown in Fig. 4. At the lower end of the curve for 15 per cent CO_2 is found the answer, 16.5, on the stationary scale.

In using this slide rule exact answers should not be

[1] 30 Church Street, New York City.


FUEL COST CENTS PER 1000 LB. EQUIVALENT EVAPORATION
EQUIVALENT EVAPORATION FROM AND AT 212° PER LB. FUEL
FUEL COST DOLLARS PER TON
O'NEILL-PAYNE
FUEL COMBUSTION CALCULATOR
PATENTED JUNE 21-1921
PER CENT EFFICIENCY
THOUSAND B. T. U. PER LB. OF FUEL
LB. AIR PER LB. COMBUSTIBLE
FIG. 1
FIG. 2
FIG. 3
FIG. 4

FIGS. 1, 2, 3 AND 4. SETTINGS OF THE FUEL-COMBUSTION CALCULATOR FOR VARIOUS BOILER PROBLEMS

Fig. 1—For 14,500 B.t.u. fuel, 15 per cent CO^2 and a flue temperature of 700 deg. F., the boiler efficiency is 75.7 per cent. Fig. 2—With 14,500 B.t.u. fuel and 75.7 per cent boiler efficiency, the equivalent evaporation, per pound of fuel, is 11.2 lb. Fig. 3—With fuel at $5 per long ton and with an equivalent evaporation of 11.2 lb. per pound of fuel, the fuel cost is 19.6 cents per 1,000 lb. equivalent evaporation. Fig. 4—Where all the combustible is carbon, 15 per cent CO^2 indicates that 16.5 lb. of air is supplied per pound of combustible.

expected, because the data used in the computation are an indication rather than an exact measure of boiler performance. At the same time it should be useful for comparing the results obtained by different methods of operation.

Furnace Engineering Company's Stoker Replacement Parts

With the idea of improving upon the design of the standard types of underfeed stokers, the Furnace Engineering Co., 5 Beekman St., New York City, has perfected three stoker parts suitable for replacement in existing installations. These replacement parts are the so-called Type "A" grate bar, a set of extension grate bars, and a side-wall grate bar.

Several of the Type "A" grate bars may be seen in Fig. 1. The objects of these bars are to give better air distribution, according to the particular combustion conditions to be met, and to reduce maintenance charges by making replacements less difficult and less expensive.

To get better air distribution, almost all of the air is forced into the fire on the side of the bar, allowing only a thin stream to come out from under the caps on top. The holes at the bottom, where the air resistance of the fuel bed is greatest, are larger than those at the top. The large number of air outlets and the small amount of air that is admitted through the top of the bars tend to prevent blowing out through thin spots in the fuel bed. The height of the bars and the number of rows of holes in them are made greater or less to meet the particular requirements of the installation.

To reduce maintenance, the bars are made up of many small interchangeable tuyere blocks, which form the sides of the retorts. The small caps on top of the bars, as shown in Fig. 1, may be taken out readily; any one of them can be removed by sliding those above it up a little way and turning it around. As these caps are the parts most liable to burn, there is an advantage in being able to replace them without having to remove a larger section, of which only a part might be burnt. The tuyere blocks, which are separated along the rows of holes shown in Fig. 1, are also easily removed, being held in place by a single rod through the length of the bar.

Fig. 2 shows some of the extension bars, the second replacement part under consideration. They are placed, of course, just beyond the lower ends of the retorts,

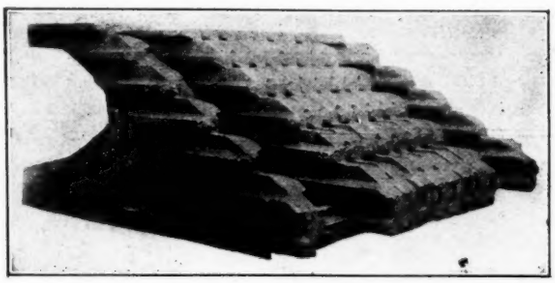


FIG. 2. NEAR VIEW OF THE EXTENSION GRATE BARS, SHOWING SEVERAL REMOVED

The interlocking construction keeps fuel from sifting through, and leaves a large number of small openings for the air to pass through.

although they had not been installed in the stoker shown in Fig. 1. The argument for them is mainly that they cut down maintenance expense, and also, by better air distribution, reduce the percentage of combustible in the ash. The designers consider the construction using a flat plate bolted to frames, with small slots for air supply and cooling, to be unsatisfactory, because of the sifting of fuel through the spaces between the plates, and because the plates warp and let in too much air at some spots and not enough at others. They have made their extension bars interlocking, therefore, so as to prevent sifting of the fuel and to provide more uniform air distribution under all conditions. The bars are held in place by a single rod, no bolts being used, so that replacement is easy.

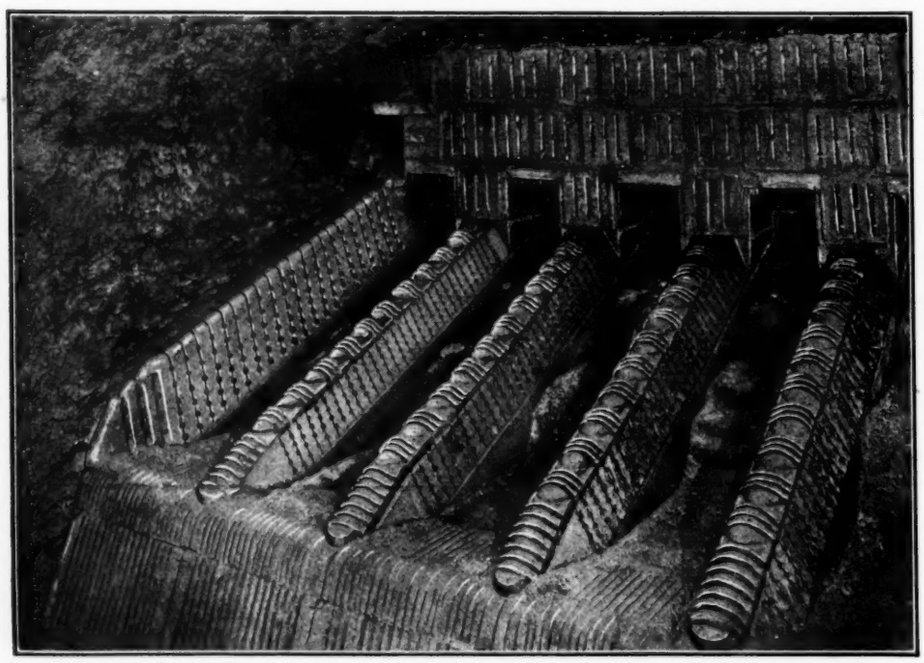


FIG. 1. THE TYPE "A" GRATE BAR, DESIGNED FOR BETTER AIR DISTRIBUTION AND LOWER MAINTENANCE

At the left is shown also the side-wall grate bar, which keeps clinkers from interfering with the movement of the coal down the retort.

The third replacement part is the side-wall grate-bar unit, a drawing of which is given in Fig. 3, and which is also shown at the left in Fig. 1. The interesting

feature of this bar is that it has independently controlled upper and lower air zones, as shown in Fig. 3. The reason for this double zone construction is that in other forms of side-wall bars, air is likely to blow out through the fire along the side walls, and so make it difficult to get a proper fuel bed thickness at the side,

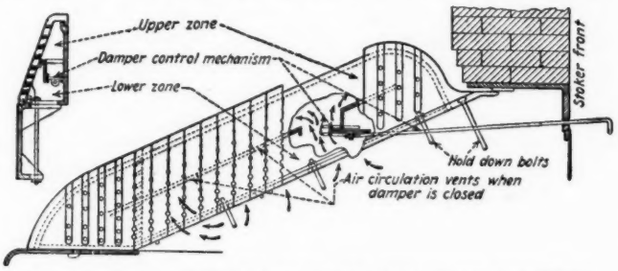


FIG. 3. THE SIDEWALL TUYERE, SHOWING INDEPENDENTLY CONTROLLED AIR ZONES

Closing the damper prevents more than a little air from passing out through the top rows of holes, until the fuel bed thickness at the side is great enough to stand the full air supply.

with resulting excess air. With this arrangement, very little air is let into the upper zone of the tuyere blocks until the fuel bed thickness is right, when the air supply at the top can be increased by the damper shown in Fig. 3, according to requirements.

Another feature of this side-wall unit, but which is not shown in the illustration, is a steam pipe that may be run through the upper zone in case the coal to be burned contains low-fusing ash, as in the Middle West, and which makes it possible to break down clinker by forcing steam out through the upper holes. Steam and air may be used at the same time or independently, and the steam may be admitted when necessary by the operator or automatically by the plunger stroke or other means.

Canada Added 12 Per Cent to Its Water Power in 1921

Although Canada quite naturally shared the general business depression of 1921, it can scarcely be said that the hydro-electric industry in that country marked time with other industries, for during that year Canada's installed hydro-electric power increased over 12 per cent through the installation of almost 300,000 hp. of additional capacity.

It has been calculated that the installed horsepower in Canada increased 153 per cent from 1900 to 1920. The horsepower per 1,000 of population developed by water power in Canada was 47 in 1902, 198 in 1912 and 280 in 1920, whereas in the United States the figures were 26, 51 and 93 respectively.

A more striking comparison between Canada and the United States may be made by bringing in the subject of coal consumption. According to present figures there is 194 per cent more water power developed per capita in Canada than in the United States, while the consumption of coal per capita in the United States is greater than in Canada by 159 per cent in industries, by 150 per cent in electric power plants, and by 50 per cent in the general average for all uses, and this in spite of the colder climate in the northern country. These figures show not only the extent of Canada's water power development, but also the marked effect of such development upon the consumption of coal. It has been estimated that, at the price of coal being charged at the time represented by the foregoing figures, the coal saved by Canada's lower per capita consumption represents $146,500,000 per year, which would have had to be spent on importing coal if the water power had not been developed. As the capital invested in water-power development in Canada now represents about $534,000,000, it is pointed out that the sum saved by not having to buy coal represents a return of 27½ per cent on the investment.

The latest estimate of Canada's available undeveloped water-power resources, calculated on a basis of 24-hour power at 80 per cent efficiency, is: 18,255,316 hp. at ordinary minimum flow, or 32,075,998 hp. that can be depended upon for six months in the year. The installed water-power capacity, as of Jan. 1, 1922, is 2,755,980 hp., of which 298,815 hp. was installed during 1921.

This increase of installed power made in 1921 was divided among the provinces approximately as follows: Nova Scotia, 13,000; New Brunswick, 9,000; Quebec, 90,000; Ontario, 174,000; Manitoba, 14,000.

The Power Commissions of Nova Scotia and New Brunswick have successfully carried out the first provincial developments and are practically ready to deliver electrical energy to the principal cities.

In Ontario the Queenston-Chippawa plant of the Hydro-Electric Power Commission of Ontario has been placed in operation with two 60,000-hp. units installed.

In Manitoba the Manitoba Power Commission has extended its activities, and the Manitoba Power Co. has under active construction an important development at Great Falls on the Winnipeg River, with an ultimate capacity of 168,000 horsepower.

This information is obtained from an official report, "Hydro-Electric Progress in Canada," which has just been issued by the Dominion Water Power Branch, Department of the Interior, Canada.

Lubrication of Oil-Engine Cylinder

The needs with regard to lubrication of internal-combustion engines are not at all comparable with those of the steam engines using saturated steam. A brief stoppage of the oil flow to a Diesel-engine cylinder might easily result in a piston seizure or abrasion of the working surfaces. It is of the greatest importance that, having installed a mechanical lubricator to give a regular supply of oil to a given spot, there should be full confidence that the lubricator used is capable of achieving this object for long periods of time and over a wide range of load and temperature.

It is also essential that the lubricator be capable of a wide range of adjustment, enabling the speeds to be cut down to a very low point, with every confidence that the flow will be maintained. Some forms of sight-feed lubricators show oil that is not going to the cylinder, whereas what is needed is to see the oil and the amount of oil that is being actually fed into the cylinder. In some cases it is also advisable to include the time factors and to know the moment at which the oil was being fed into the cylinder in relation to the position of the piston. This is the best form of cylinder lubrication for the oil engine.

In case a blowoff line breaks or a tube bursts, the fires should be immediately cut out and the boiler should be kept supplied with enough warm water to overcome that lost by the break until all pressure is off and steelwork is cool.

Trouble-Hunting Suggestions

By N. L. Rea*

Long experience in chasing trouble on power equipment or chasing trouble chasers after trouble has conceived some general ideas that may be interesting, if not instructive. A trouble hunter should approach a job with an open mind and without preconceived theories, then make a careful investigation, collecting all the evidence and any history of past troubles, repairs or changes. The whole evidence should be analyzed with common sense and engineering skill.

Many a man has been so busy trying to prove a preconceived theory that he has overlooked entirely some simple cause of the trouble. For instance, the armature of an old bipolar generator had been rewound, and the customer complained that it sparked badly when placed in service. One man returned from the job with a mathematical digest that proved (?) that the machine was poorly designed, in that the brushes spanned too many commutator bars. This theory was taken with considerable doubt in view of fourteen years of good behavior previous to the armature burn-out. A second man asked a few questions when he noticed that the generator pulley had a poor polish compared to the driving pulley. A new pulley had been installed when the machine was reassembled, the old one having been broken during disassembly. This new pulley was eccentric and out of balance. Turning the pulley and adding twelve pounds of lead in balancing, restored the machine to its previous good behavior.

Preparation Necessary Before Starting Work

It is advisable to lay out a scheme that will start on broad general principles and to eliminate step by step unnecessary tests. A little thought in most cases will give a general plan that will fit any particular case and that can be followed in logical order without repeating tests or following false clues.

Many a motor has been completely dismantled because it wouldn't run, when the real trouble was a blown fuse somewhere in the feeder circuit. On the other hand, the trouble isn't always electrical. The writer once took six quarts of shelled corn and meal out of a gristmill motor that was running hot.

Not so very long ago several high-grade engineers spent hours trying to get power from the generator of a frequency-changer set and finally discovered quite by accident that the coupling bolts were sheared and only the motor end was running. This particular set was fairly well inclosed for forced-air ventilation. The shaft was exposed, however, and a start at the source of power would have saved much time and mental strain, to say nothing of the chagrin felt by all concerned. Some of the party still hear occasional echoes.

A man was sent several hundred miles on a hurry call. A large motor driving a centrifugal pump refused to start, and naturally, the trouble must be electrical. The outfit had been operating during the daytime only and was installed under an open shed. The first cold snap of the fall had caught the pump with a foot or so of water in the bottom of the casing. The troubleman gathered an armful of kindling and built a small fire under the pump casing. The local man, naturally, was not particularly pleased with his record in the case.

A customer reported that a vertical-pump motor was in bad shape as it would run for about five hours, then blow the fuses and refuse to start for several hours. The first examination showed the starting box in bad shape from overloading; temporary repairs were made and a new box installed later. The trouble continued, however, and a thorough investigation was ordered. At the end of five hours the fuses blew right on schedule time. The troubleman at once tried to turn the motor by hand and could not move it with a lever, although it had turned easily before starting the run. It was necessary to remove the coupling bolts and run the motor before the customer would believe the trouble was in the pump. The pump was submerged and it was some time before the pit was emptied.

In the meantime the pump was found to turn freely again and, when dismantled, showed signs of rubbing on one side of the casing and on the bottom of the impeller. This was the first chance the trouble shooter had had to see the layout. The pump was connected by a 6-in. pipe to one end of a cylindrical tank 12 ft. in diameter and about 100 ft. long. The liquor in this tank was circulated through steam-heated vats by the pump and returned by gravity. At the start of the run the tank and liquor had a temperature of about 40 deg. F. and at the end of five hours this had increased to about 150 deg. F. The expansion of the tank had to move toward the pump as the far end was against the pit wall. Two of the foundation bolts under the pump were sheared off and the other two were minus heads; they therefore acted as dowel pins to hold the bottom of the pump.

The motor held the upper end of the shaft, and the expansion of the tank tipped up the pump casing, springing the shaft and the pump bearing until the impeller rubbed enough to blow the fuses. This trouble had been going on for months.

An almost endless series of examples could be given, all showing the necessity of a troubleman keeping his wits about him and tackling all investigations with an open mind and on a broad basis.

*Construction engineer, General Electric Company.

Performance of British Central Stations

The accompanying table showing fuel consumption for central stations in Great Britain is from a report of the Electrical Commissioners covering 501 power stations and reprinted in *The Engineer* of London. The grouping in the table is by locations served rather than by the individual stations.

AREA GROUPING OF STATIONS CONSUMING COAL OR COKE

Location	Average consumption of coal or coke, lb. per kw.-hr. generated	Lowest consumption by any station in area, lb. per kw.-hr. generated.	Highest thermal efficiency of any station in area, per cent.
Northumberland	2.08	1.78	17.75
Durham	2.72	2.33	14.25
Glasgow and District	2.98	2.58	13.30
Cumberland	3.17	2.60	9.46
Lancashire	3.22	2.31	13.94
South Wales	3.27	2.56	10.94
Yorkshire	3.29	2.19	13.58
London and District	3.36	2.20	14.28
North-East Scotland	3.47	2.61	12.16
Birmingham & Salop	3.95	2.78	12.31
South-West Counties	3.98	1.70	15.50
North Staffs	4.00	2.24	11.80
Leicestershire	4.34	2.62	11.70
Eastern Counties	4.52	2.72	9.74
South-West Scotland	4.65	2.97	8.27
Northants and Essex	4.68	2.93	10.52
Derby and Notts	4.87	3.09	11.12
Edinburgh & District	4.92	3.50	7.56
North Wales	5.52	2.18	10.37
Guernsey	....	2.20	11.55
Average for Great Britain	3.32	1.70	17.75

EDITORIALS

Thickness of Shell Plates in Externally Fired Boilers

A COMMITTEE of the American Boiler Manufacturers' Association recently circularized its membership for their ideas regarding the maximum allowable thickness for the sheets of horizontal return-tubular boilers. There is no specific restriction of this thickness in any of the ordinarily used Codes or Rules, although the A. S. M. E. Code provides that when the sheets are over nine-sixteenths of an inch thick they shall be planed at the girth seams to one-half inch, reducing the total thickness at the joint to one inch. As the strength of the circumferential joint must not be less than one-half that of the longitudinal seam for unsupported heads, nor less than thirty-five per cent when fifty per cent of the load on the head is carried by tubes or through braces, this does, in effect, limit the allowable thickness.

The replies to the committee's questionnaire showed a wide variation in opinion. Any limitation upon the thickness of the plate restricts the pressure for which this type of boiler may be used. If constant cleanliness could be assured, there would be little, if any, need of such limitation, but with bad feed water or carelessness with regard to scale and especially oily impurities, the danger of bagged, burnt or ruptured fire sheets may be enhanced by more than ordinarily heavy plates.

The difficulty appears to lie principally in the joints. The longitudinal seams can be kept out of the fire, but the girth seams must be exposed to the products of combustion and are likely to give trouble. The reduction of a thick plate to the one-half inch required by the Code is, of itself, likely to make a tight and sound joint difficult of attainment. We should be glad to have the opinions of our readers upon the subject, especially when based upon experience with plates of more than ordinary thickness.

The Multiplication of Energy

AN AVERAGE workman has an energy output of about one-tenth horsepower, according to T. T. Read of the Bureau of Mines. But this tenth of a horsepower is capable of producing many times the equivalent energy when aided by modern power-driven equipment. Comparison between the energy expenditure of a man and the energy value of his production is particularly striking in the case of the coal miner whose expenditure of energy in an eight-hour day is about equal to that available from two pounds of coal. But this same miner working under American conditions can get out 8,800 pounds of coal in his working day and thus multiply his energy by 4,400.

The measure of modern civilization is based upon the standard of living of the community as a whole, but our consumption of goods and material cannot be greater than our production. Mr. Read well says: "Coal, petroleum and water-power are, therefore, the real sources of strength in an industrial civilization."

The same authority goes on to estimate from the probable future supplies of fuel the millions of horsepower-years that are represented by the resources of the principal countries of the world. The United States, of course, leads—in fact, almost equals all the rest of the world when measured on the basis of these energy resources, for in this country there are coal deposits almost, if not quite, as great as all those known throughout the rest of the earth.

But the resources alone are not a fair basis for measurement of industrial development. It is the utilization of the resources that is important. America leads in this particular, also. In no other country is there so tremendous a development of coal production or power-driven equipment. The American workman, therefore, has the greatest opportunity to multiply his limited human strength many-fold through the use of power. Hence, it is no exaggeration, to say that one man-power does not equal one-tenth horsepower, as it would if only muscular strength were considered. It really equals many horsepower; just how many is determined by the extent to which the strength of arm is supplemented by brain-power for control of steam or electricity.

Distorted Figures Inspired Lack of Confidence

IF NUMERICAL comparisons are to have any value and establish confidence, they must be fair and unprejudiced. Mathematical legerdemain has been carried on to such an extent during the last few years that one is almost led to believe that we are developing into a race of mathematical jugglers. Why this should be, there seems to be no good reason, especially in engineering, since to those who do not know, the figures do not mean anything, anyway, and those who understand them are capable of applying some check or analysis to obtain at least an approximate idea of their correctness. Of the old figures that we used to say "could not lie," most of us are now pretty skeptical until they have been checked with some unbiased source of information.

Such statements as the industries of this country use forty-two per cent of the coal and produce twenty-seven per cent of the power, while the central stations use twelve per cent of the coal and produce forty-two per cent of the power, and manufacturing power plants require an average of eight and one-half pounds of coal per horsepower hour, where the average central station requires only one and one-half pounds, do not mean anything other than a distorted presentation of the facts. The forty-two per cent of power given as being produced by the central stations also includes that produced by hydro-electric plants, which last year developed thirty-seven per cent of the power generated in central stations. Correcting this figure for hydro-electric generated power the percentage becomes about twenty-six and not forty-two. If the value of one and one-half pounds of coal per horsepower-hour is corrected to represent the output for coal-burning plants, it becomes about two and four-tenths pounds per horsepower-hour,

or three and two-tenths pounds per kilowatt-hour, which is probably a fairly accurate figure.

Included in the coal used in industry is that consumed for heating and industrial processes. This latter represents probably about fifty per cent of the total, although there are no reliable figures available for this division. However, taking the coal required for heating and process work into consideration and making due allowance for power produced by waterwheels, will undoubtedly give a figure considerably below eight and one-half pounds per horsepower-hour. It is a fact that there are many industrial plants that are operating uneconomically, but the large number producing power economically must not be overlooked. In plants that have use for all their exhaust steam, a kilowatt-hour can be produced with the expenditure of about twenty-five per cent of the heat units that are required in the best central-station practice operating condensing. Conditions are so involved as to make it almost impossible to obtain data that show the true conditions as a whole in the industrial plants of the country. Nevertheless, if comparisons are to be made, these should endeavor to show the actual conditions as nearly as possible, if these data are to establish confidence and be of value in solving the power problem.

The Liquid-Fuel Situation

JUST now the refiners have in storage an enormous amount of fuel oil which apparently is a drug on the market. How to dispose of this stock, which is in danger of becoming a liability rather than an asset on the balance sheet, is a serious problem. The ability of the small refiner to buy crude petroleum for refining purposes is limited by reason of this investment in non-moving stock. The result has been low crude-oil and high gasoline prices.

Three factors prevent the more general adoption of boiler oil even when the supply is ample and the price attractive. In the first place the refiner or marketer consistently refuses to enter into a contract to supply oil at a set price for a reasonable length of time. In addition the manufacturers of fuel-oil burning equipment have, by adding refinement after refinement,, brought the price of the heater, burner and pumping equipment to a point where oil must be used for a considerable period to justify the investment.

A third factor, that of transportation and distribution of the oil, must be considered by prospective buyers. With the exception of certain points along the Atlantic coast and in the oil-producing states, it is impossible to obtain a dependable supply of oil without large storage facilities.

The average power-plant executive, before he converts the plant to burn oil, must be convinced—first, that the refiner will enter into a contract covering a reasonable time at a set price for the oil; second, that there are dependable transportation facilities; and third, that the oil-burning equipment can be installed at a reasonable price.

If the refiner and the equipment men will get together and arrange a workable plan, oil will cease to be a drug on the market. The refiner will profit by the liquidation of a stock that is now almost a liability. The equipment manufacturer will profit by increased sales, and many power plants will be able to reduce operating costs by the substitution of oil for coal.

An Opportunity for the F. A. E. S.

TENTATIVE plans for the Sesquicentennial Exposition to be held in Philadelphia in 1926 are now well under way. Celebrating, as it will, the one hundred and fiftieth anniversary of the Declaration of Independence, it will be a National rather than a local affair in which engineering achievement will play a leading rôle. In fact, it has been proposed that an International Engineering Congress be held in conjunction with the Exposition.

The Federated American Engineering Societies was conceived and founded to provide a channel through which co-ordinated thought and action of the various engineering societies might be expressed, especially in matters of National concern, and to impress upon the public the potency of the engineering profession in rendering service to society. To date there is a marked feeling that the net results have failed to meet the most ardent expectations. Here is an opportunity for the Federation to assume leadership. The machinery is set and the task as if made to order. Let there be no hesitation in taking advantage of the opportunity.

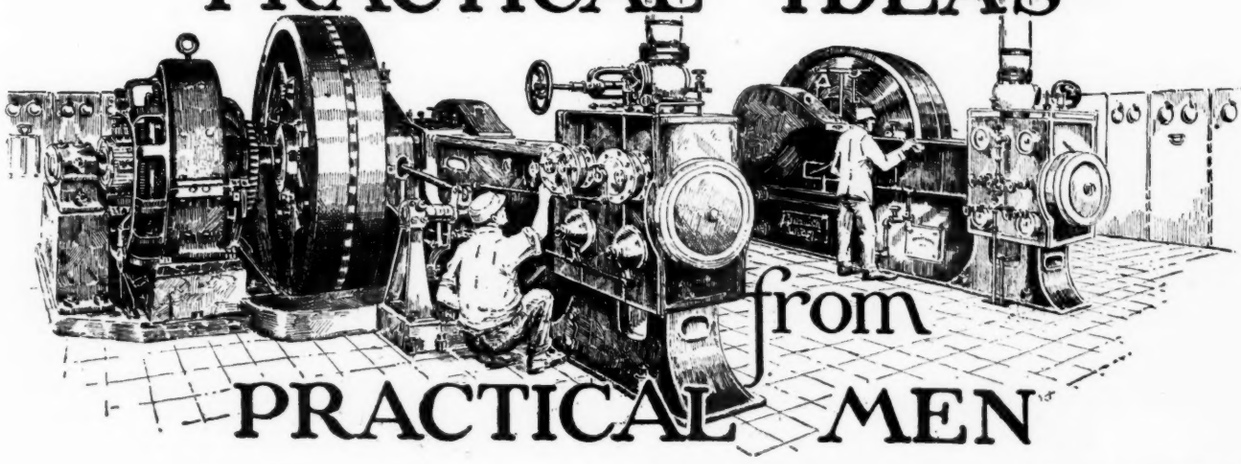
Much credit is due the local engineering bodies in Philadelphia for their initiative in helping to get the Exposition started. Their efforts must of necessity be largely local, and there is work enough for all. Assumption of sponsorship for an International Engineering Congress by the Federated Societies would in no way detract from the glories of the local societies; instead, the latter as part of the national body, would share in the accomplishments that would result from such a conference.

There is a lot of talk and hubbub about the coal strike. Charges and counter-charges are being hurled back and forth by the operators and the miners. As usual in such disputes, the consuming public is standing to one side, powerless, but hoping for the best. But while hoping, is it not also in order to wonder a little as to just how great an effort is being made by the two sides to prevent a long-drawn-out battle? Furthermore, an aggressive spirit is in the air; the operators and the miners both feel it. "Now is a good time," they say, "to fight it out and see who's who." Bravo! But in the meantime, what of business?

Efficiency in a power plant does not depend altogether on the high efficiency of the individual apparatus, but on an intelligent combination of equipment that will produce a kilowatt-hour with the least expenditure of heat units commensurate with overhead and operating charges and reliability. As an individual unit steam drive for auxiliaries is about as economical as it is possible to obtain, but when considered in the plant as a whole, other methods of driving auxiliary equipment may show distinct advantages.

There was once a purchasing agent who made an annual report showing how much he had saved the company during the year. This figure, amounting to thousands of dollars, was obtained by totalling the difference between the price paid for each purchase and the highest quotation. Anyone can see the fallacy of such a report, but some still persist in believing that they save a dollar every time they buy an article that costs a dollar less.

PRACTICAL IDEAS from PRACTICAL MEN



Bards, Take Note

I am making a collection of verse, whose subject matter relates to the sciences or to the closely related branches of engineering, with the intention of publishing at some future date an anthology of such verse.

It has occurred to me that there may be among your readers many who have verses of this character in their possession and who would be willing to contribute them to this collection. Will you kindly grant me space for this appeal to your readers to send to me copies of such verses, together with the necessary details of authorship, and place of publication (if previously published) to my address, Box 130 M. I. T., Cambridge, Mass. The receipt of verses will be greatly appreciated and duly acknowledged. CHARLES E. RUBY.

Cambridge, Mass.

Fallacy of Using 60,000 T.S. Steel for Boilers

In states having no boiler laws, there are still a few that own and operate boilers who pay little attention to modern boiler specifications. If one of these men were to build a factory, he would give the matter a great deal of study or engage some one of recognized ability to handle the matter, and only the best plans and the most reliable materials would be employed, but in the matter of purchasing a boiler, the cheapest that can be had seems to be the object.

What I have in mind is that there are still a few who will have boilers made of flange steel stamped 60,000 T.S. because the builder can use thinner plates and reduce the price a few dollars. To one who is not informed, it is quite natural that steel plates stamped 60,000 T.S. are much better and stronger than those stamped 55,000 T.S. This would be true in point of tensile strength, if the figure mentioned represented the actual strength of the material. However, on account of the impracticability of closely controlling the chemical content which affects the tensile strength, a range of 10,000 lb. is allowed in specifications, and the minimum of the range is used in computing the safe working pressure of a boiler.

Checking the manufacturers' test reports on several hundred plates made by some of the leading mills, I find that the actual tensile strength reported runs from 57,000 to 64,000 lb. and averages about 59,500 lb. (these figures are per square inch cross-sectional area) for all plates mentioned. This steel conforms to A. S. M. E. Boiler Code requirements and is stamped Fire-Box 55,000 T.S. Checking over another lot of plates marked 60,000 T.S., furnished by the same mills, I find the actual tensile strength does not exceed 60,000 lb. Even if it did and appeared stronger in point of tensile strength, the steel of the lower tensile strength is much better, because it has other elements of value, such as increased ductility, etc. These make up for the lower tensile strength, making it just as worthy under the same stress and safer for boiler construction than the steel that runs near the upper margin. So it seems that plates stamped 60,000 T.S. are in most cases no higher in tensile strength than those stamped 55,000 T.S., and if they are the steel is almost too hard to be used, running close to the danger line.

To further illustrate the inconsistency of using plates marked 60,000 T.S. for boiler construction, let us take, for example, a boiler 84 in. in diameter made of plates $\frac{3}{8}$ in. thick, stamped 55,000 T.S. and having a longitudinal joint efficiency of 94 per cent; using a factor of safety of 5 will give 150 lb. working pressure.

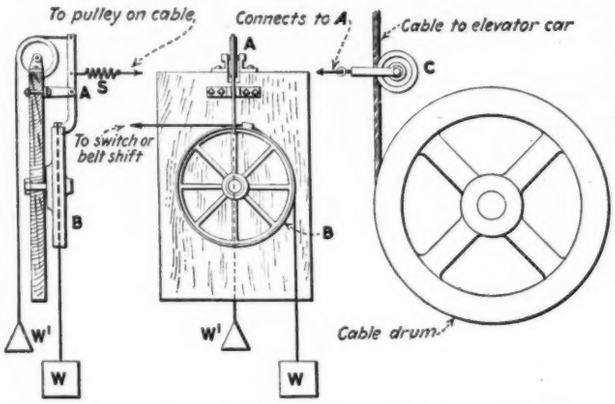
On the other hand, the same working pressure can be obtained for an 84-in. boiler constructed of plates $\frac{7}{16}$-in. thick, stamped 60,000 T.S., having the same joint and factor of safety. But taking into consideration all the facts as stated with regard to what steel manufacturers' test reports show and the better elements found in steel of the lower tensile strength, the boiler made of $\frac{7}{16}$-in. thick steel 60,000 T.S. for 150 lb. pressure would have a factor of safety of only 4.6 as compared to the one made of $\frac{3}{8}$-in. steel, even though it is stamped 55,000 T.S. P. E. TERROY.

Chattanooga, Tenn.

Slack-Cable Device for Elevator

Some time ago I had to devise and install a slack-cable device on an old-type elevator driven by a straight and a crossed belt. The arrangement of this device is shown in the figure. This problem was simplified materially by the machine being installed at a considerable distance from the wall back of the drum, which allowed locating the device directly back of the machine. A wheelbarrow wheel was pressed into service as one of the essential parts of the equipment and was mounted on a board, as indicated at *B* in the figure. A dog *A*

was hinged above the wheel and attached through a tension spring *S* to a small sheave *C* on the hoisting cable. From the top of *A* a rope runs over a small sheave to a weight *W'*. On the wheel B is attached a weight *W* and a rope that goes to the belt shifter on the down-motion belt. Should the car stick in the shaft on the down motion or land on the bottom of the pit, and the hoisting cable become slack, the rope attaching sheave *C* on the cable to dog *A* would loosen and allow



SHOWS CONSTRUCTION OF SLACK-CABLE DEVICE

weight *W* to pull dog *A* out of the notch in wheel *B*. This in turn would permit weight *W* to turn wheel *B* and operate the belt shifter and stop the machine. In practice this device was found to stop the machine before 6 in. of cable would unwind from the drum.

In the installation where this device was installed, no support was necessary for sheave *C* running on the hoisting cable, other than the tension spring *S*, which also took care of the change in distance between sheave *C* and dog *A*, due to the cable traveling across the drum. Contrary to what might be expected, sheave *C* showed no tendency to work down on the cable at any time. If it were thought desirable, sheave *C* could be run on a shaft supported in swinging hangers, and these hangers attached to dog *A*. This arrangement would permit mounting the device at any convenient place, and the hangers could be attached to *A* through suitable pulleys. No doubt this piece of equipment seems crude when compared with a slack-cable device found on modern elevators, neverthlesss it has served a good purpose since being installed, and a similar device would undoubtedly prove useful on other old-type elevators that have no automatic stopping arrangement should the cables become slack.

M. E. KURTZ.

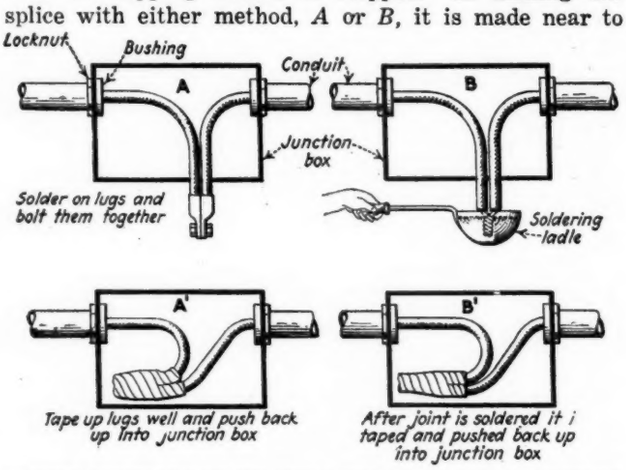
Sacramento, Cal.

Methods of Making Splices in Electric Wires

When making splices in light and power wiring, workmen frequently use a blow-torch for soldering the joints. This practice is liable to damage the insulation for a considerable distance from the splice if care is not exercised. Not infrequently, insulation failures in electric wiring can be traced directly to this cause. Of course it is necessary to make splices in junction boxes, and the methods suggested in the figure have been found to be satisfactory in every way.

A splice made by soldering on lugs and bolting them together, is shown at *A*. Lock washers are placed under the nuts to prevent them from working loose. *B* shows how the splice is made by twisting the wires together into what is known as a fixture or pigtail splice. After the splice is made, it is soldered by dipping it into a pot of hot solder. *A* has some advantages to its credit. The splice can be made without damaging the insulation, and it is convenient in case a section of the conduit has to be moved to make room for new machinery that is being installed, since the connection can be unbolted and it is not necessary to cut or unsolder and untwist the splice. Trouble in the feeder can be quickly located by unbolting the splices so as to break the circuit up into sections. When the trouble is found and repaired, the splices that were taken apart can be quickly rejoined.

When a blow-torch is held on a splice, it takes a considerable time to get it hot enough to melt the solder. While the wire is heating up slowly, the heat follows the wire back under the insulation and at the same time the flame is burning the insulation. Nine chances to one the rubber is cooked back into the conduit and after the joint has cooled, any attempt to move it cracks the insulation. Fig. *B* overcomes this difficulty by not having any flame on the splice and heating it up quickly. As soon as the part to be soldered has a good coat, the pot is removed and the splice will begin to cool. To solder the splice, the pot is raised up so as to dip the joint into the solder, then lowered. Generally a thick coat of solder will stick to the wire, indicating that the joint is not hot enough. The pot is raised and lowered till the solder runs off the wire freely, leaving a very fine coat with no lumps or drops hanging to the wire; then the dipping should be stopped. In making the splice with either method, *A* or *B*, it is made near to



SHOWS METHODS OF SPLICING ELECTRICAL CONDUCTORS

the end of one conduit and then bent back up into the box so the cover can be closed. In order to more clearly illustrate the method of splicing only one wire is shown in the figure.

MARIN PHILLIPS.

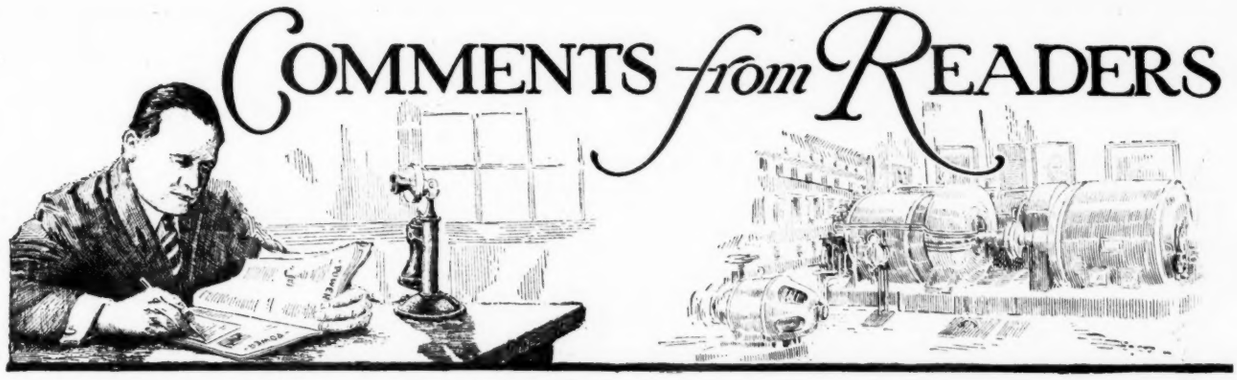
South Kaukauna, Wis.

What Pressure and Temperature for Fuel Oil?

Will some reader tell me the best oil pressure to carry in burning fuel oil that uses steam for atomizing. What governs this?

Also how would you know that you were carrying the right temperature on the oil. How close to the flash point is it customary to carry the temperature?

Baltimore, Md. F. J. HERBERT.



Boiler Supervision in Australia

Some time ago I noticed in *Power* a report giving the number of boiler accidents for the year 1920. The figures given are appalling to any intelligent engineer, and I consider these facts are the strongest evidence that can be produced for the necessity of having under government control an Inspection of Machinery Act similar to that which is in force in this State of Queensland, Australia, under which I am proud to say there have been no fatalities in connection with steam boilers.

For your information I would mention that this Inspection of Boilers Act has been in force in this state for twenty-two years. I have been connected with the department as an Inspector for twenty years, and during the last twelve years I have been responsible for the administration of the department as Chief Inspector. During the whole period mentioned only one fatality has happened as a result of mishap with steam boilers. I am of the opinion that with proper supervision by competent engineers who have had at least ten years' experience with steam boilers and machinery under working conditions and under the control of a departmental head apart from any interference from interested persons, there is no reason why steam boilers should cause fatalities such as referred to in your article. J. HENDERSON.

Brisbane, Australia.

Suggestion Box for the Power Plant

Mr. Craig's letter in the Feb. 21 issue on the subject of a suggestion box for the power plant brings up a matter that should interest every power-plant manager, for the proper use of the suggestion box idea offers one of the best opportunities for developing improvements and little kinks concerning practical operation which it is almost impossible to bring out in any other way. The difficulty, of course, is to get the men to co-operate properly and to keep their interest aroused.

My experience has been that it is best to develop the suggestion-box idea for the power plant in connection with the entire plant. Practically every power plant except the central stations is connected with a manufacturing or industrial establishment. The best suggestion-box scheme I have worked has been along these lines: Instead of putting up a box and leaving the rest to the men (for usually it does not take long for the interest to lag), we put in the pay envelope once a month a suggestion blank, making it easy for the men to send them in. These forms were not merely the regular suggestion form, but each month we asked for specific suggestions concerning some particular phase of the plant operation; for instance, welfare, lighting and heating arrangements, improvements to processes or process machinery, etc.

Realizing that the power plant represented one of the best possibilities for effecting savings, we would put in a request every few months on some phase of the power-plant work, such as suggestions for improving the appearance of the boiler and engine room, how to save lubricating oil, improvement in coal and ash handling, etc. Under this scheme we found the men kept interested and on the watch for improvements. This had the further advantage that the suggestions were usually better thought out than when they were allowed to be sent in promiscuously.

My recommendation, therefore, in the operation of a suggestion box, is to ask for suggestions for certain definite subjects at certain intervals, and you will find the men interested in gathering together their ideas and advancing them at the proper time.

We establish four cash prizes for each month's contest—$10, $5, $2.50 and $1, and we have found that usually the honor of being "in on the money" was even a greater incentive to effort than the actual cash value of the prizes. M. A. SALLER.

Philadelphia, Pa.

Belt Slipping Causes Flickering of Lights

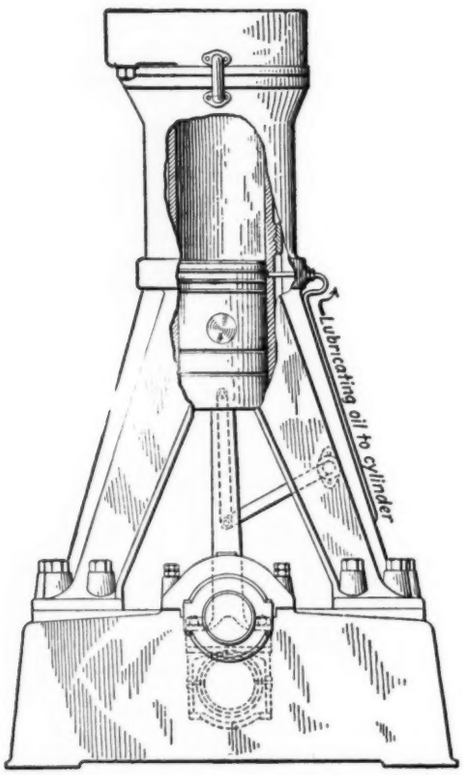
In *Power*, Mar. 7, 1922, J. F. Bernard tells how the slipping of a generator belt caused lights to flicker, and this brings to mind a similar case, although it happened under somewhat different circumstances. It was in a paper-mill power plant equipped with a 1,000-kw. three-phase 60-cycle 480-volt turbine-driven alternator supplying about 700 kw. load. About half the load was on a 400-hp. motor belted to a lineshaft from which beaters and jordans were driven. When some of these got in bad condition and caused the motor to be overloaded, the belt would slip—not enough to make it squeak, but so it could be noticed by the wave in the slack side. This caused the motor to take a fluctuating current, and although the generator was equipped with a Terrill regulator the lamps would flicker violently, until the belt was treated with dressing and tightened.

Another case of flickering lights was found to be caused by suspending the lamps and shades separately in a semi-indirect lighting fixture. Building vibration caused the light and shade to have different motions and gave the appearance of a flicker, when the bare lamp gave a steady light. H. D. FISHER.

New Haven, Conn.

Lubrication of Diesel Engines

In the February 14 number is an article by P. P. Talaty referring to proper lubrication of the main pistons in a Diesel engine. In the illustration accompanying the article herewith reproduced the lubricating oil is shown introduced between the piston rings, when the



METHOD OF LUBRICATING DIESEL CYLINDER

piston is in its lowest position. This method gives far better results than the one suggested by Mr. Talaty as an improvement, admitting the lubricating oil higher up on the cylinder wall.

With proper oil grooves under the piston rings to lead the oil along the piston, sufficient lubrication is obtained with the arrangement as fitted by the builder.

If lubricating oil is admitted above the piston, a large percentage of the oil will find its way into the top piston-ring grooves, where it will carbonize and stick the piston rings. The same thing will also occur if too much lubricating oil is fed with the present location of oil pipes.

The fact that the cylinders wear more at the top than at the bottom is in all cases due to wear from piston rings and not to any side thrust from the piston body. When the piston is at the top, the high compression and combustion pressure gets in behind the piston rings and presses them harder against the cylinder walls, and the wear is greater at the top, diminishing as the piston moves down on the working stroke. This wear cannot be eliminated by merely changing the location of the oil feed.

If the service has been anywhere near continuous for seven years, as stated by Mr. Talaty, the $\frac{1}{8}$-inch wear can hardly be considered abnormal, especially as there may be local conditions that should also be taken into consideration, such as dust, etc.

Auburn, N. Y. C. E. BOHMAN.

Ash Handling in Generating Stations

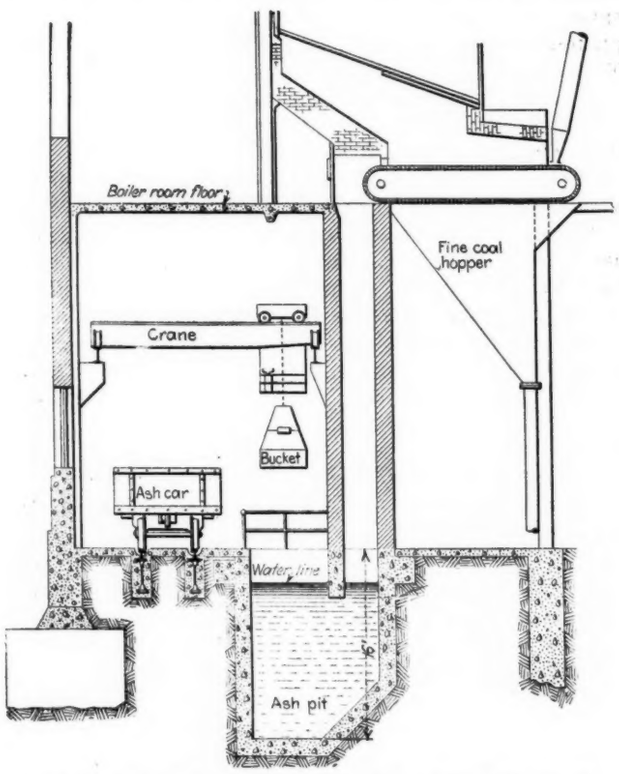
The article in the Jan. 17 issue on ash handling, by L. R. Lee is of interest, but there is one method that has been overlooked. This method consists of discharging the ash through a shaft to a water-sealed ash-pit, to be removed with a clamshell bucket, the general arrangement being shown in the illustration.

This system was installed at the North East Station of the Kansas City Power and Light Co., Kansas City, Mo., where it has been in operation for the last $2\frac{1}{2}$ years.

In operation the refuse, dropping from the rear end of the chain-grate stoker, falls through a 3 x 10-ft. shaft, into a water-filled pit 30 ft. below. The slope of the pit causes most of the ash to roll out into the open section. The rear wall, extending 4 ft. below the normal water level, prevents air from entering the shaft.

In this installation each pit is 24 ft. long, 11.5 ft. wide at the center and 16 ft. deep, with a capacity of 2.3 tons per linear foot, sufficient for approximately 56 hours' operation of two 10 x $17\frac{1}{2}$-ft. stokers set under a 13,500-sq.ft. boiler operating at 200 per cent of rating. This is the operating capacity of the pit, as the submerged wall will not permit utilizing the full volume.

An electric bridge crane, equipped with a $1\frac{1}{2}$-cu.yd. clamshell bucket, is used for removing the ash from the pits. This bucket has a number of $\frac{3}{4}$-in. holes drilled through the plates to allow the water to drain back into



WATER-FILLED ASHPIT OF LARGE CAPACITY. ASH REMOVED BY CLAMSHELL BUCKET

the pit while the bucket is being raised to the height of the ash car. Some of the water, of course, is deposited with the ash in the cars, but practically all of this finds its way back into the pit through properly installed floor drains made large enough so that plugging with fine ash is a remote possibility.

In severe winter weather the cars are allowed to stand for a short period after loading, to drain more thor-

oughly before being sent to the railroads. From experience in unloading these cars around the property, we find that the freezing of the ash is no worse than where the sprinkler system is used, and we have heard no complaint from the railroads who get most of the ash.

The operation of removing the ash from the pits and loading the cars is at no time a disagreeable task, there being no hot gases, dust or hot clinker to contend with, and no ashpit doors to jam or freeze up in the winter.

Owing to the large body of water in the pit, the heat given up by the ash is radiated quickly. It is only when the room temperature is unusually low that any vapor is in evidence. As the shaft forms a dead air pocket, this vapor is given off on the pit side. During this period a small amount of house-service water is discharged into the pits. An overflow connecting through all pits and to the sewer takes care of any excess water. The water is carried high enough so that the removal of ash will not drop the level below the submerged wall and allow air to enter the furnace. With this system the ash can be removed at any time with no danger of excess air entering through the ashpit to cool the furnace. This permits removal during peaks as readily as during light-load periods and air infiltration through the ashpit is reduced to a minimum.

Ordinarily, the ash is removed once each day, requiring one hour of a crane operator's time for each 50-ton car of ash loaded. This time includes loading the car, sampling the ash from each pit and moving the car from pit to pit with the aid of the crane and clamshell bucket. The power consumption while loading is approximately 20 kilowatt-hours.

The refuse samples taken from each pit contain the same amount of combustible as upon leaving the grate, as fuel can be burned out in the water-filled pit, so that a reliable ashpit loss can be determined.

This system has reduced the maintenance on ash handling to a minimum by eliminating firebrick linings, steel bunkers, sprinkler systems, ashpit doors and conveyors. The only maintenance is that necessary to the bridge crane, which to date has been little, consisting principally in the care of the motors. It was at first expected that frequent renewal of the bucket cables would be necessary, but this belief has been discredited by the fact that only two cables have been replaced in the 2½ years of service, and these from natural wear.

While an installation of this kind may not be possible, or even advisable in a number of cases, it would at least bear investigation if considering a new plant, as its operating merits and the yearly average cost per ton of ash handled, would be difficult to equal.

EDWARD L. McDONALD, Combustion Engineer,
Kansas City, Mo. Kansas City Power & Light Co.

Further Data on Boiler Failure At Springfield Armory

Having read Mr. Atkinson's article in the Feb. 7 issue on the near failure of one of the boilers at the Springfield Armory, due to the development of a crack near the flange of a dished head, I was interested in the further details and the editorial in the March 7 issue, where attention is called to the fact that the crack was probably due to the small radius of the bend at the flange rather than to an inadequate thickness of material.

The new Canadian Interprovincial Regulations would bear out this contention. As the rule given in Sec. 218 states, "The inner radius of the flanging at the outer edge of an unstayed dished head shall be not less than *four times* the thickness of the plate and shall in no case be less than 1½ in." There is no requirement for extra thickness in heads of this type, but the prohibition against the radius exceeding the diameter (without staying) is maintained. In the case under discussion the rules would call for an inner radius of 1¾ in. instead of 1½ in., the minimum allowed.

For working pressure when the pressure is on the concave side the foregoing rules give:

$$P = \frac{E \times St}{R \times 80}$$

where

P = Maximum working pressure in pounds per square inch;
E = Thickness of plate in sixteenths of an inch;
St = Tensile strength of plate in pounds per square inch;
R = Radius to which head is dished in inches.

Assuming the head on the Armory boiler had been dished to a radius of 42 in. (the drum diameter) and taking the determined tensile strength of the material (64,000 lb.), the allowable working pressure would then be $\frac{7 \times 64{,}000}{42 \times 80} = 133.33$ pounds.

Under the Interprovincial Rules the percentage of carbon allowable in boiler-plate steel is the same as the Code and Massachusetts Rules; namely, 0.12 to 0.24 per cent for plates ¾ in. thick and less.

Macleod, Alta., Canada. F. SEYMOUR.

Safety in Tagging Valves

In discussing the article on "Tagging Valves" in the Feb. 21 issue, I shall describe how I handled a similar job. I had charge of all piping, valves, meters, etc., in a factory consisting of three buildings, and believe the same or nearly the same procedure can be followed with other factories.

All piping was painted according to a certain code, a list of which was furnished to all concerned to make them familiar with the various lines of pipe. The color scheme was as follows: Fire lines, red; cold water, blue; live steam, white; steam return, brown; gas lines, violet; air lines, green; oil lines, black.

The valves were tagged. Those above ground carried a metal plate 3½ x 5 in., painted white with the marking in black, the lettering being about 2½ in. high, so that the valve number could be seen across the room. The underground valves (located in pits) carried brass tags on which the valve numbers were stamped. The system of numbering the valves made use of a letter before the number, which helped to identify its function. All valves on fire lines were lettered "F"; on cold water lines, "W"; on live steam lines, "S"; on steam return lines, "R"; on gas lines, "G"; on air lines, "A"; and on oil lines, "O." Wherever possible the valves were numbered in order; for example, the main valve shutting off the cold-water supply to the factory as a whole was "W-1," which was located in a pit where the main entered the factory grounds. The other valves on the same line were numbered in regular order.

Small pocket size notebooks, containing full information relative to all valves, such as valve number, location,

size, function, when to be opened or closed, and by whom, were kept by the factory engineer, boss pipefitter, superintendent and foremen. The purpose in supplying the notebooks to the foremen was to acquaint them with the location of the valves that controlled the supply of cold water, sprinkler water, steam, etc., in their own department, in case of a serious leak or breaking of a sprinkler head. These books were also supplemented in each department by posters giving additional information to those in charge.

As specified in these notebooks, certain valves could be opened and closed only by certain ones in authority, chiefly those in the sprinkler system. These valves normally should be kept open. However, in case of repair or break when a valve is closed a red paper tag is attached to it, giving all details such as when closed, why closed, by whom, and for how long. A duplicate of this tag is sent to the superintendent. When the repair is completed and the valve is opened, a green tag giving this additional information is sent to the superintendent, who files the two tags for future reference.

Bridgeport, Conn. D. FLIEGELMAN.

The letter by C. P. Corey in the Feb. 21 issue brings out a point worth consideration.

A plant that I took charge of some years ago contained an unusual amount of piping, without identification marks or tags of any kind. When endeavoring to familiarize myself with the valves and pipe lines, I traced one pipe through a basement, across one floor of a mill, through a bridge into another mill and up two stories to a dead end.

A good color scheme is in my opinion better than any other method of distinguishing pipe lines, and when the use of a line is permanently discontinued it should be disconnected and taken down. C. W. PETERS.

New York City.

Utilizing Flue Gas To Preheat Air

In reply to the three questions raised by DeWitt M. Taylor on page 315 of *Power* for Feb. 21 under the title, "Utilizing Flue Gas to Preheat Air to Furnace," I should say:

1. The heating of the furnace air is advantageously done by gas which has already passed the economizer; that is to say, by the use of gas at less than 400 deg. F.

2. Air preheaters constructed of plates are particularly adapted to counter-current systems, but the importance of that method of circulation should not be exaggerated. Computation shows that there is not a great difference between the divers systems for small differences of temperature.

3. The effects of condensation upon the surfaces is not at all the same for an air preheater as for an economizer.

The following interesting letter upon this subject by Mr. Utting, appeared in the Jan. 27 issue of *The Engineer* of London.

The comparatively long life of thin plates, such as are used for air heaters, might be surprising if one overlooked the fact that the action of condensation is very different from that of the feed-water economizer, and on which experience most of the criticisms on air heaters have been based. Condensation occurs when the temperature of the surface in contact with the flue gases falls below a certain value, depending on the pressure and the water vapor contents; that is, the dew point. The gases resulting from the combustion of an average coal contain 206 grains of water per pound. The corresponding dew point is 95 deg. F. at atmospheric pressure.

In an economizer, the temperature of the tube surface in contact with the gases is practically equal to that of the water inside the tube. In an air heater the temperature of the surface is about equal to the average of the temperatures of the flue gases and the air. The result is that condensation occurs on the economizer tubes as soon as the water temperature falls below 95 deg. F. In the air heater the condensation will occur only when the flue-gas temperature falls at least to 130 deg. F. with cold air at 60 deg. F. or with gases at 158 deg. F. if the air were at 32 deg. F. From the point of view of condensation, the two recuperators act very much less in an air heater than in an economizer.

EMILE PRAT.

Etablissements Emile Prat-Daniel, Paris.

Why the Radiators Would Not Heat

The information contained on page 151 of the Jan. 24 issue indicates that the primary cause of the original trouble might have been the faulty operation of the vacuum trap *B*, Fig. 1, which was intended to drain the tee at the bottom of the 4-in. riser. With the drain in good condition the accumulation of water could not occur.

One lesson to be learned from this experience is that no matter how high the initial pressure is on a good reducing valve, the discharge pressure will remain constant. That is, after all, the real function of the reducing valve.

Fortunately or unfortunately, the valve cannot differentiate between water pressure and steam pressure, so when a water column builds up on the discharge side to such a height that the pressure produced by it is greater than that for which the valve is set, only one thing can happen, and that is, the reducing valve closes. And it will remain closed until the pressure on the control diaphragm is reduced. This evidently occurred with the piping system in question.

The credit for better operation has been given to the change in the weight arrangement, judging from the sentence, "After the weights were placed on the lever as shown at *A*, any desired pressure could be maintained." No doubt the statement is correct, but I am afraid the conclusions drawn were based on circumstantial evidence and that the drain line became operative owing to an accident to, or a casual inspection of, the trap. Shutting the steam off the line would not improve conditions and make the water drain out faster. Actually, the effect would be the opposite. A stoppage in the drain would seem to be the logical cause of the trouble.

Mr. Sheehan does get directly to the point when he says that the amount of steam used should be metered, such as gas or electricity. "With such an arrangement customers would use no more steam than is actually needed." I agree with both statements, but in the next statement we are unconsciously led into dangerous territory when he says that "there is no doubt that a vacuum system is best when properly installed and good vacuum traps are placed on the returns."

Vacuum systems do have a legitimate field. There are installations which, owing to the position of the radiation and the route that the return piping must follow, cannot be operated by any other system. Better service can sometimes be obtained with a poor piping job by the use of a vacuum system. There are some real arguments in favor of it, such as greater range of heat control and perhaps lack of water hammer.

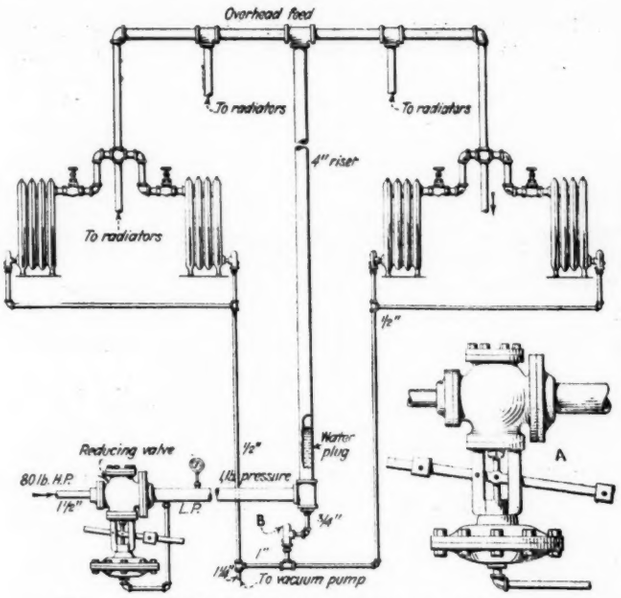


FIG. 1. SHOWS HEATING SYSTEM AS INSTALLED

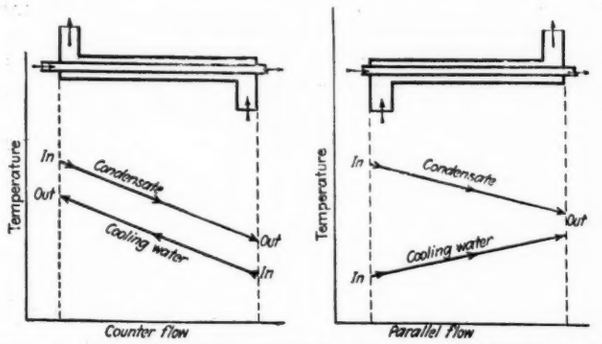


FIG. 2. THE TWO PRINCIPLES OF FLOW ILLUSTRATED

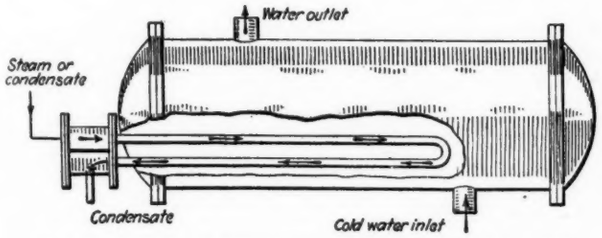


FIG. 3. USUAL METHOD OF CONNECTING HEATER WITH INTERNAL COILS

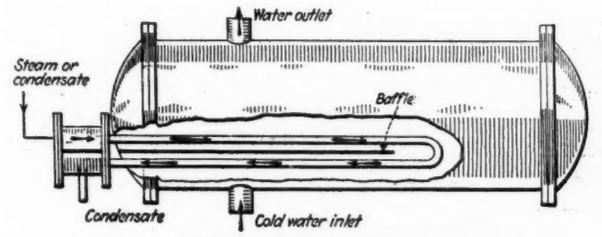


FIG. 4. THE COUNTERFLOW PRINCIPLE APPLIED TO FIG. 3

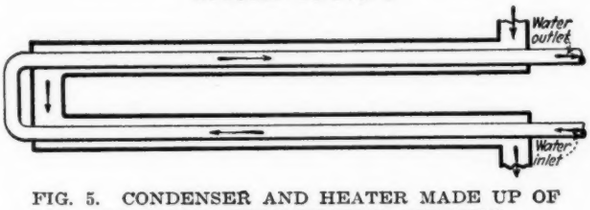


FIG. 5. CONDENSER AND HEATER MADE UP OF STANDARD REFRIGERATING FITTINGS

There is at least one real objection to a vacuum system—the way it is usually operated, it is not economical. More steam is used than is actually needed to give good service. Vacuum traps do not always remain tight when the scale and rust get in them. Then the vacuum "draws" vapor through the radiators into the return, and in order to maintain a vacuum, cooling water is required. Jet condensers are most frequently used, and the process consists of buying (or pumping) cooling water, and injecting it into the return line by way of the jet condenser, where the waste heat is absorbed by it, and then discharged into the sewer.

Because there are usually hundreds of vacuum traps, it is almost impossible to keep them all in good operating condition, and it is much easier to open the injection water valve a little more than it is to locate and correct the cause of the trouble. There is, however, a method by which, with a small investment, most of this heat can be utilized.

One system that has been used with much benefit is the water economizer or preheater for the hot-water service. The economizer is essentially a surface condenser, and all the heat absorbed from the returns is utilized in the hot-water system.

In the application of an economizer to an existing system, the greatest economy can be realized by the use of the "counterflow" principle of heat absorption. The two systems are illustrated in Fig. 2.

The parallel-flow result is obtained when the usual hot-water heater with the internal coils is piped in the ordinary manner, and the condensation seldom leaves the coils cooler than the outgoing cooling water when the piping is similar to that shown in Fig. 3. Better results can be had by using the arrangement in Fig. 4.

A more efficient arrangement has been effected by using standard refrigerating fittings, and constructing a heat exchanger as shown in Fig. 5. This works on the counter-current principle. Such a system will reduce the condensate discharge temperature within a few degrees of the inlet cooling-water temperature.

Pittsburgh, Pa. J. C. HOBBS.

A Lead-Base Babbitt Gives Best Results

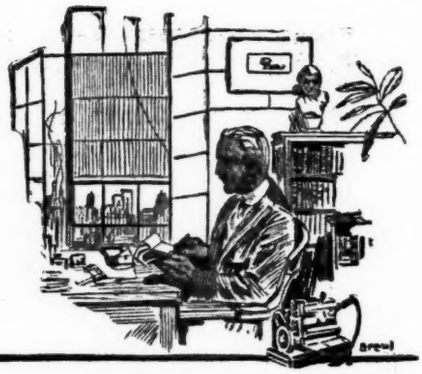
A recent issue of *Power* contained an article on "Bearings and Babbitt Metal," in which is recommended a babbitt metal consisting of 80 per cent lead and 20 per cent antimony, as giving better satisfaction and less trouble than a tin-base metal.

In a large woodworking shop a 42-in. smoothing planer gave trouble that could not be overcome by the use of a tin-base babbitt. The babbitt was finally removed and a lead-base metal substituted. The machine has given no trouble since, but in spite of this fact the man in charge of laboratory insists a tin-base babbitt is superior to a lead base. In this particular shop there are numerous woodworking machines large and small, and I have noticed the machines with lead-base bearings give less trouble and last longer without renewing the bearings. All of the electric motors that I have had occasion to take down have had lead-base bearings, which give good satisfaction. FRED W. ONGLEY.

Rock Island, Ill.

All Bureau of Standards publications that have been issued are listed with abstracts and summaries in Circular 24, which is distributed free by the Bureau at Washington.

QUESTIONS AND ANSWERS

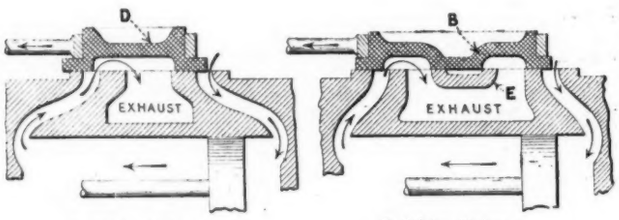


"D" and "B" Slide Valves

What is the difference between a "D" slide and a "B" slide valve? M. C.

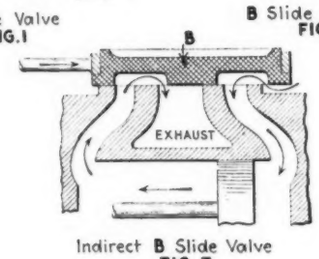
The designations D slide valve and B slide valve are commonly employed according to the resemblance of the valve section to the letters D or B.

The ordinary slide valve shown double cross-sectioned at *D*, Fig. 1, is called a "D" valve. A long valve having its cross-section shaped like the letter B as shown at *B*, Fig. 2, is called a "B" valve. When the valve is made



D Slide Valve
FIG. 1

B Slide Valve
FIG. 2



Indirect B Slide Valve
FIG. 3

in this form, the steam ports may be shorter than would be required with a short D valve. In place of making the D form long enough, the valve is made in the form shown in Fig. 2 so it may be supported by the bridge *E* across the exhaust passage.

Another form of B valve is shown at *B* in Fig. 3 in which steam is admitted under the ends of the valve. This form is an indirect valve, as for admission of steam at the beginning of the stroke of the piston the valve must be moved in a direction opposite to the direction of motion of the piston.

Effect of Ash on Coal Value

What effect has the presence of different proportions of ash and slate on the value of steaming coal? B. N.

The efficiency of combustion ordinarily decreases with increase of ash or slate and incombustibles mixed with the coal and there is also the additional expense for storing, handling, firing and ash disposal. High-ash coals require higher draft because the ash forms an insulating layer around the coal, which hinders the oxygen from coming in contact with the combustible material and the ash may clinker and clog the fuel bed so the higher draft required results in more leakage of air through the walls of the setting. Hence, the higher the percentage of incombustible the greater the loss from excess air and the lower the efficiency obtainable for the combustible element in the coal.

The relative value of coals according to the percentage of ash content varies with different boiler plants. Under average plant conditions the relative values are about as follows:

Taking 0 per cent ash as 100, 10 per cent ash in dry coal would have a value of 92; 20 per cent ash a value of 80; 30 per cent ash a value of 60; 35 per cent ash a value of 40; and 40 per cent ash a value of 0.

Troubles from Clinkering Coal

For firing a hand-fired boiler we are using coal that contains considerable slack and clinkers badly. What should be the method of firing to reduce the trouble? J. F. S.

Carry a thin fire and stoke small charges at a time. Promptly cover the brightest spots of the fuel bed with fresh fuel to prevent holes from burning through that will allow coal to drop to the ashpit. Avoid stirring of the fire. As far as possible any working of the fire-bed that may be necessary should be done from the bottom. Keep the bed level by stoking. Leveling the fuel bed with a rake or other firing tool is likely to cause clinker by gathering together the ash or shifting the ash to a hotter part of the fuel bed. Keep the ashpit as cool as possible. Have the ashpit doors open and regulate the draft with the uptake or stack damper. Promptly quench any ashes or coal that may fall through the grates. If the ashpit is watertight, keep water standing in it. If that is impracticable, blow steam under the grate. The exhaust of a pump or any other supply of waste steam turned into the ashpit will be beneficial.

Steam Accounted for by Indicator Diagram

What is the most accurate method of determining the water rate or steam consumption of any engine under load from the indicator diagram? M. D.

There is no method for determining the steam consumption of an engine directly from the indicator diagram with reasonable accuracy. The steam consumption per indicated horsepower per hour can be approximately estimated from diagrams that are similar to those obtained from other engines of the same type and design whose water rate has been determined by test made of the weight of boiler-feed water required for

the generation of the steam used, or by accurately metering the steam or weighing the exhaust in the form of condensate.

In estimating the steam consumption directly from the diagram, it is necessary to regard the engine as a meter, assuming that it cuts off a certain number of cubic inches of steam each stroke and being able to ascertain the pressure and volume from the indicator diagram, we might be able to compute the weight of steam received if the steam were a non-condensible vapor. But that cannot be done because at the point of cutoff a large part of the steam which has passed from the boiler to the engine will not be in the form of steam, but of moisture due to condensation against the cooler retaining surfaces. As expansion proceeds, some of this water is re-evaporated, but most of the re-evaporation occurs after the exhaust valve has opened and the engine receives no benefit from that part of the re-evaporation. Hence, the steam accounted for by the indicator diagram is not to be confused with the amount of steam which is actually passing through the engine, for the latter may be 20 to 40 per cent greater.

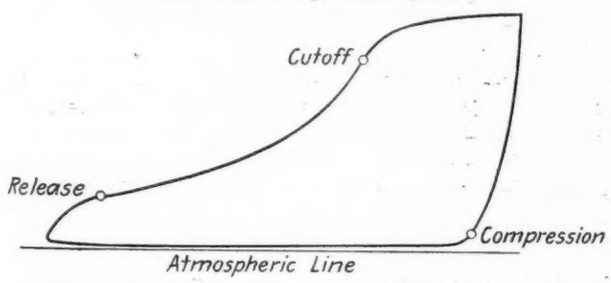
However, computation of the steam accounted for by the diagram is interesting and instructive, showing when compared with the actual measured consumption, the extent of the cylinder condensation and interaction between the steam and the cylinder walls.

The steam accounted for by an indicator diagram, expressed in pounds per i.hp. per hour may be found by using the formula,

$$\frac{13{,}750}{m.e.p.}\ [(C + E)\ W_c - (H + E)\ W_h]$$

in which

$m.e.p.$ = Mean effective pressure;
C = Proportion of direct stroke completed at points on the expansion line near cutoff or release;
E = Proportion of clearance;
H = Proportion of return stroke uncompleted at point on compression line just after exhaust closure;
W_c = Weight of 1 cu.ft. of steam at pressure shown at cutoff or release point;
W_h = Weight of 1 cu.ft. of steam at pressure shown at compression point.

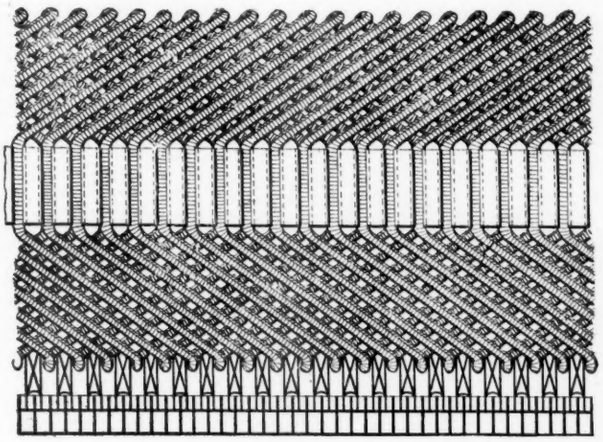


The points near cutoff, release and compression referred to are indicated in the figure.

Reconnecting a 220-Volt Motor To Operate as a 55-Volt Generator

I desire to convert a direct-current 10-hp. motor to operate as a 55-volt generator and have a capacity of about 7½ kw. The full-load current of the motor is 40 amperes at 220 volts, and it operates at 1,300 r.p.m. The armature has 109 coils containing two turns of No. 11 double-cotton covered wire, wound into 55 slots, therefore there is one side of four different coils in each slot. The armature is series wound for 4-poles and the commutator has 109 bars. D. F. Z.

Since the machine is now designed for 220 volts and has four poles, and the coils are connected in series, each field coil has 220 ÷ 4 = 55 volts impressed upon it; therefore, if the four field coils are connected in parallel, they will be correct to operate on 55 volts. The armature is connected series in a four-pole winding; if it is connected parallel, it will be good for 110 volts. Connecting the winding in double parallel will make it good for one-half of 110, or 55 volts. Two coils are wound together in each slot, therefore these may be treated as a single coil, as indicated in the figure, and the two commutator bars connected together as



SECTION OF RECONNECTED WINDING

shown. If a jumper cannot be conveniently connected between pairs of commutator segments, the insulation may be removed from between the segments at the back end and each pair of bars soldered together.

There are 109 coils and 109 commutator segments, but only 108 of them can be grouped as indicated in the figure. One coil can be left dead in the winding, and the odd commutator bar can be connected to one pair that it is adjacent to. Since the coils are wound in pairs, there should be a total of 110 coils in the original winding, with one coil left dead. If this is the case, the companion coil to the dead one should be left out of circuit when the winding is grouped for 55 volts. If there is not a dead coil in the original winding, then there must be a single coil and this one should be left dead in the new grouping.

Four sets of brushes will be required, and these should be somewhat thicker than for the original winding; how much will depend on the size of the original brushes. For the 55-volt winding the brushes on each stud should have at least 1½ sq.in. cross-section, and this will require using a brush of high-current capacity such as a graphite or electrographitic type.

To have the machine generate 55 volts, it will probably be necessary to operate it at about 1,400 r.p.m., instead of 1,300 r.p.m. as for the original machine. This speed should give some excess voltage to be taken care of with the field rheostat.

[Correspondents should sign communications with full names and post office addresses.—Editor.]

Interpretations of the A.S.M.E. Boiler Code

REQUESTS for interpretations of the Boiler Code are acted upon by the Boiler Committee, their formulated replies being submitted to the Council of the American Society of Mechanical Engineers. The inquiries and replies are published from time to time in *Power*, with such explanatory comments and illustrations as seem advisable for a clear understanding of the interpretations on the part of engineers in general. The last group of interpretations published in *Power* was in the issue of Jan. 31, 1922.

Case No. 375 (Reopened)—Inquiry: Is it permissible, under the requirements of the Boiler Code, to weld a seam in a vertical firebox not over 38 in. in diameter, and in length ranging from 20 in. up, by the autogenous or fusion process where the firebox has no support other than the tube sheet, mud ring and fire-door?

Reply: It is the opinion of the committee that, under the requirements of the Code, autogenous or fusion welding is not permissible for the seam in the firebox of a vertical-tubular boiler, unless the sheet containing the seam is properly supported by staybolting or other form of construction.

The above inquiry and reply of case No. 375 are exactly as given in the Jan. 31, 1922, issue of *Power* except that the last part of the original reply read "unless the sheet containing the seam is supported by staybolting."

Case No. 377—Inquiry: An opinion is requested from the Boiler Code Committee, concerning the applicability of Par. 428 of the Code relative to the composition of the tin filling for fusible plugs, if used, where the boiler is to be operated under a working pressure of from 350 to 500 lb. per sq.in., so that the temperature of the steam under working conditions will be far above that specified for the melting point of tin.

Reply: There is nothing in the Code pertaining to the use of fusible plugs on boilers operated at pressures involving temperatures near or above the melting point of tin. It is accordingly proposed to revise Par. 428 by the addition of the following: "Where the boilers are to be operated at working pressures in excess of 225 lb. per sq.in. gage, the use of fusible plugs is not advisable."

Paragraph 428 reads: "Fusible plugs, if used, shall be filled with tin with a melting point between 400 and 500 deg. F., and shall be renewed once each year." The Code does not require the use of fusible plugs in any case. It does, however, specify the kind and location of plugs if they are used.

The melting point of pure tin is around 450 deg. F., corresponding to a gage pressure of 407 lb. The temperature corresponding to a steam pressure of 350 lb. (gage) is 436 deg. F. So it is evident that tin-filled fusible plugs are not suitable for such pressures.

Case No. 378—Inquiry: If an internal boiler-feed pipe enters at full size into a steam and water drum and then into a closed vessel within the drum, wherein the end of said feed pipe is open, and the said closed vessel has a series of openings, accessible for inspection, and the combined areas of which openings are largely in excess of the open end of the pipe, and means are provided for blowing down the interior closed vessel, does the construction meet the requirements of Par. 314 of the Code?

Reply: If the closed vessel within the drum, into which the open end of the feed pipe projects, has openings largely in excess of the area of the open end of the pipe so that there may be no possibility for them to become clogged by incrustation and providing the vessel has means for blowing down in cleaning, it is the opinion of the committee that the construction described will meet the requirements of Par. 314.

Paragraph 314, reading "The feed pipe of a boiler shall have an open end or ends inside of the boiler," is obviously designed to eliminate the possibility of any obstruction to the flow of water. Case No. 358, covered in the Nov. 1, 1921, issue of *Power* disapproved of the use of a spray nozzle on the end of the feed pipe unless special precautions were taken to prevent clogging of the openings.

Case No. 379—Inquiry: Would it meet the requirements of the A.S.M.E. Boiler Code for an authorized inspector to stamp a boiler as a 200-lb. pressure boiler if same meets all the requirements regarding the boiler proper but the cross-connection between the drums is composed of extra-heavy pipe and extra-heavy flanged cast-iron fittings?

Reply: It is the opinion of the committee that a boiler so fitted with the cross-connection using extra-heavy cast-iron fittings would not meet the requirements of Par. 9 of the Code.

Paragraph 9 requires wrought iron or cast steel of designated grade to be used for cross-connections for pressures over 160 lb., except that malleable iron may be used, under certain restrictions, if the pressure does not exceed 200 pounds.

Case No. 380—Inquiry: Is it necessary, under the requirement of Par. 336*b* of the Boiler Code, that a boiler head must be stamped by the manufacturer in two places when it is less than 12 in. in diameter and, due to the tube spacing, it is impossible to find room for more than one stamping?

Reply: It is the opinion of the committee that as long as there is one stamp legible on a miniature boiler, the intent of the Code is met, where the parts are so small that it is impossible to apply two stamps.

Case No. 381—Inquiry: An interpretation is requested of the requirement in the last sentence of Par. 257 that calking shall be done with a round-nosed tool, where a form of flat-faced tool of the full width of the plate is being successfully used so as to thicken out or upset the end of the plate with pressure, instead of hammering. It is pointed out that with this method there is no danger of scoring or damaging the plate underneath the calking edge and the result is a very firm and effective result in calking.

Reply: It was the intent of the committee in imposing this requirement that calking should be done so that the plate at or beneath the calking edge will not be scored or damaged. If the tool is of such shape as to upset or compress the edge of the plate without splitting it and will not score or damage the adjacent plate, the requirements of this paragraph may be considered as fully met.

Paragraph 257 follows: "The calking edges of plates, butt straps and heads shall be beveled to an angle not sharper than 70 deg. to the plane of the plate, and as near thereto as practicable. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than $\frac{1}{8}$ in. Calking shall be done with a round-nosed tool."

Case No. 382—Inquiry: Is it not permissible, under the requirements of Par. 180 of the Code, to use plate thicknesses for the shells and tube sheets of horizontal-return-tubular boilers thinner than those specified in Par. 18 and 20, providing the maximum allowable working pressure formula gives the desired pressure with a factor of safety of 5?

Reply: It is the opinion of the committee that it is not permissible, under the rules of the Code, to use plate thicknesses in any case for shells or tube sheets less than the minimum thicknesses specified in Par. 18 and 20 of the Code.

Paragraph 18 specifies that the following shall be the minimum thickness for any boiler, of shell plates, and dome plates after flanging:

Shell Diameter	Minimum Thickness
36 in. or under	$\frac{1}{4}$ in.
Over 36 in. to 54 in.	$\frac{5}{16}$ in.
Over 54 in. to 72 in.	$\frac{3}{8}$ in.
Over 72 in.	$\frac{1}{2}$ in.

Paragraph 20 specifies that the minimum thickness of the tube sheets of horizontal return tubular boilers shall be as follows:

Diameter of Tube Sheet	Minimum Thickness
42 in. or under	$\frac{3}{8}$ in.
Over 42 in. to 54 in.	$\frac{7}{16}$ in.
Over 54 in. to 72 in.	$\frac{1}{2}$ in.
Over 72 in.	$\frac{9}{16}$ in.

Case No. 383—Inquiry: Par. L-18 states in the first sentence that the gage thickness of the tubes shall not be less than a certain amount. In the second sentence it states that the gage thickness shall be measured by the B.W. gage and the thickness at any section must not vary more than one gage below or one gage above that specified. Does

this require using one gage heavier than the nominal gage in order to meet the requirements?

Reply: The intent of the committee in formulating this rule was that the gage thickness referred to in the first paragraph of L-18 of the Locomotive Code, described a nominal gage to be used. The gage thickness referred to in the second paragraph specifies that whichever gage is used, the limitations are minus one gage and plus one gage. Therefore, if a particular gage is specified for the boiler tube, the limits in gaging are one gage less and one gage more than that specified.

Applying Scientific Methods to Industry

That, in brief, is what the Mellon Institute of Pittsburgh is doing, as explained by its director, Dr. Edward R. Weidlein, in an interesting talk given at a joint meeting of the Chicago Section of the American Society of Mechanical Engineers and the Western Society of Engineers, held on the evening of Mar. 20. It had been thought that Dr. Weidlein might give some of the results of the high-temperature work on insulation that the Institute is now conducting, but as this subject is to be reserved for the spring meeting of the A.S.M.E., the speaker limited his talk largely to the Institute itself, reviewing the rapidity of its growth into one of the best research laboratories in the country and giving a good idea of the scope of the work and the method of conducting it.

He explained that fellows, singly or in multiple, are assigned exclusively to the work of the donor, the latter being the term applied to the firms or individuals for whom an investigation is being made. Between them there is full co-operation, so that laboratory findings may be applied to practical problems. The donor pays the salary of the fellow, fees for use of apparatus, expenses, etc., and gets his experimental work done by an expert with the facilities of the Institute behind him, at one-fourth the cost of the same work in his own plant.

Up to the present the Institute has developed over 200 new chemical processes, is now or has been conducting research in 51 distinct subjects and is serving over 3,000 manufacturers in this country. Although nothing is published without the consent of the donor, an average of about 75 papers are released per year, and at present there is in preparation a series of books.

Test results on 85 per cent magnesia as insulation for steam piping, boilers, refrigerating systems, etc., were mentioned. While the accepted figure of loss from bare pipe is 3 B.t.u. per hour per square foot per degree difference in temperature, it was shown to be much higher as the temperature of the steam increased, and to vary with the diameter of the pipe. With insulated pipe, it was stated, the loss increases slightly with the temperature, but in no such ratio as for bare pipe.

As a finale there was presented a motion picture emphasizing the importance of using insulation on the steam piping and on the furnace in the home. Enthusiastic discussion followed on insulation for underground piping, the effect of air velocity over the piping and a number of other subjects.

Stoker Replacement Parts

BY RUSSELL T. GRAY

There is no other piece of equipment in the modern power plant that is worked as hard as the stoker—and abused as much. And yet all the better-known makes of mechanical stokers stand up remarkably well under long overloads and abuse. When replacements of wearing parts are necessary, however, spare parts should be ordered with the same care that marked the original purchase of the stoker.

New equipment is not bought by the pound, like so much cast iron. The man who buys a stoker buys the raw material plus the engineering skill and experience that is necessary to shape that material into the smoothly functioning apparatus that he wants in his plant, which may be the result of years of patient, day-after-day striving for betterment. This is just as true of replacement parts as it is true of the original stoker.

Some engineers order spare parts from local foundries, in the belief that a penny saved is a penny earned. High freight rates have tended to increase such local buying, with the results that many stokers repaired with parts cast at local foundries are falling down under the daily grind, not because of stoker faults but because the new parts interfere with the proper operation, rather than help.

Many complaints received by stoker manufacturers are directly traced to poorly fitted pieces made locally, which at first might be considered of little consequence. But when the perfect operation of every part of a machine is dependent on the perfect operation of every other part, it may be easily understood why one misfit can cause unending trouble with all the working parts.

Stoker parts that are subject to intense heat are usually made of a grade of iron or steel which, after years of study and experiment by the designers, has been found to give the longest service under the particular conditions surrounding that part. When these pieces finally burn out, the engineer who orders replacement parts from his local foundry usually finds that the new parts he has bought soon burn out or begin to warp and buckle. This is because such castings are made of ordinary gray iron which cannot withstand the high temperatures.

Every stoker manufacturer maintains a service department with the sole object of making replacements at the lowest cost to the user and keeping the equipment operating satisfactorily. The reputation of the manufacturer is behind every extra part sent out by the service department. If it doesn't fit or doesn't wear, the manufacturer makes good. If the locally made casting isn't right, the engineer holds the bag.

New improvements that are added from time to time are sometimes incorporated in old stokers by the service department, so that the engineer who buys parts from the manufacturer keeps his stoker up to date at very little extra cost.

Nine Engineering Societies Meet in Chicago

Under the joint auspices of the Western Society of Engineers and the Chicago sections of eight national societies, a general convention of engineers was held March 21 and 22, for the purpose of informing the engineers of the community about the engineering problems of Chicago, now pressing for solution, and the part they should take in solving these problems.

On the evening of March 21 a special inspirational meeting was held at the rooms of the Western Society of Engineers. It was featured by an address by John W. O'Leary, vice-president of the Chicago Trust Co., on "The Engineer as a Leading Citizen."

Wednesday morning's session was devoted to Chicago's public utilities and to the broad subject of city planning. Speaking on electric service, L. A. Ferguson, vice-president of the Commonwealth Edison Co., gave some interesting figures showing the greatness of the company's operations. In 1921, he said, the company sold a total of 1,700,000,000 kw.-hr., which brought an income of $36,000,000. To show the diversity of the load, the total output was divided as follows: 163,000,000 kw.-hr. to residence lighting; 163,000,000 kw.-hr. to small stores; 65,000,000 kw.-hr. to small power users; 383,000,000 kw.-hr. to wholesale users; 87,000,000 kw.-hr. in refrigerating plants; 52,000,000 kw.-hr. for the pumping of water, and 771,000,000 kw.-hr. to the electric railways, including the surface and elevated lines.

The total output, which was 4.7 per cent that of the entire United States, required 2,100,000 tons of coal during the year, or 7,000 tons daily, which came mostly from the company's own mine. The total generating capacity was 652,000 kw., although a portion of this was not in service during this period. The total investment averaged $224 per kw. A striking bit of information was the fact that the company pumped practically as much water for condensing purposes as the entire city consumed, the figures

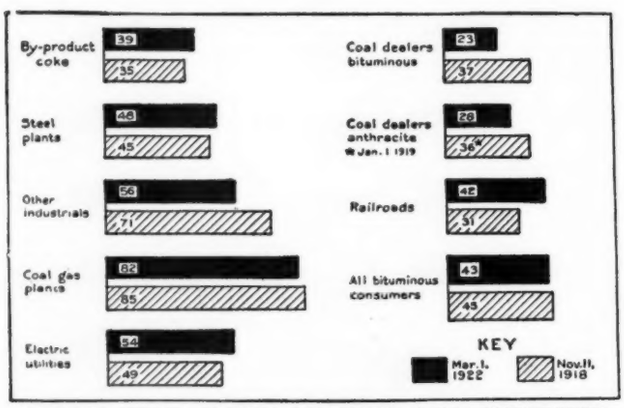
being 250,000,000,000 and 260,000,000,000 gal. per year, respectively.

H. H. Clark, consulting engineer of the People's Gas Light and Coke Co., referred to some of the larger uses to which gas is now being applied. Formerly three-quarters of the gas output were delivered for domestic use, he said, and a small fraction to the larger services referred to. He explained that these ratios are now rapidly changing and approaching those of the Edison Co., in which one-quarter of the output goes to domestic service and three-quarters to large users, such as manufacturing concerns, electric railways, etc.

As a finale, the annual banquet of the Western Society of Engineers was held Wednesday evening. Reed G. Landis told some interesting things about aerial transportation in Chicago and the speaker of the evening, David Kinley, president of the University of Illinois, delivered an interesting address on "Engineering Opportunities," dealing particularly with research.

Coal Stocks Are Now as High as on Armistice Day

Each individual consumer of bituminous coal knows quite closely how much coal he has on hand and can estimate fairly accurately his future requirements, at least for the next few months; therefore statistics of coal stocks throughout the country cannot help him to know how long he can keep his plant going in case of a stoppage in production. But such figures can show how quickly the country as a whole will begin to feel the pinch if the union miners stand



DAYS' SUPPLY OF COAL ON MARCH 1 IN COMPARISON WITH THE RECORD OF ARMISTICE DAY

The numbers of days' supply given here are based on the rate at which coal was burned in January and February; the average for all consumers was 43 days. Today it is undoubtedly greater.

their ground. When stocks are nearly exhausted everywhere, the real trouble will begin, and so it is worth while to predict that time as closely as the facts available permit.

The chart shown here, which was prepared by the United States Geological Survey, gives a comparison between the coal stocks in the hands of various classes of consumers March 1, 1922, and Nov. 11, 1918,—the day that marked alike the close of the war and the unsurpassed record of consumers' coal supply. The Survey's estimates for March indicate with practical certainty that the totals today are considerably greater than for March 1, and are, in fact, undoubtedly equal to the figures of Armistice Day, when consumers had 63,000,000 tons of soft coal in storage.

There is a considerable difference in the stocks of coal on hand in different sections of the country. From Jan. 1 to March 1 stocks were increased in most localities, but in all the New England states, in all states in the so-called Lake Dock territory and in five of the Far Western States the supply was decreased. Practically everywhere else the supply went up sharply.

New Hampshire had 788 stationary engineers when the 1920 census was taken. This shows a decrease from 992 in 1910.

British Engineers Investigate Corrosion of Condenser Tubes

The Institute of Metals (Great Britain) has recently published a paper entitled "Notes on the Corrosion and Protection of Condenser Tubes," at the offices of the Institute, 36 Victoria St., Westminster, S. W. 1. There is not space here to give a satisfactory abstract of the contents, but the following memoranda, quoted (in somewhat abridged form) from the end of the paper, sum up the conclusions in a simple manner:

1. Under all ordinary circumstances use tubes and ferrules of Admiralty alloy.

2. Give preference to tubes in which the iron is guaranteed to be less than 0.1 per cent.

3. A clause in the specifications calling for an oxidizing annealing for three hours at 350 deg. C. plus or minus 25 deg. C. is worth a trial. Such tubes must not be subsequently pickled.

4. When local corrosion has once started in a tube, it is practically impossible to stop it, even by electrolytic protection, and tubes are most sensitive to bad conditions when new. Consequently, never allow new tubes to become wholly or partly choked, but clean out as frequently as possible; later in the life of tubes this is not so necessary.

5. Steel protector blocks, if used at all, should be put into condensers at the same time as new tubes.

6. When using protector blocks or any other form of electrolytic protection, always use soft metal rings when packing tubes.

7. Electrolytic protection by motor generator or battery is worth a trial if tube losses are heavy. It should be applied to new tubes and maintained continuously, not intermittently. The details of the installation require careful consideration and are a matter of experts. Careful watch must be kept for reversal of polarity.

8. Leaky packing is a possible source of corrosion of tube and ferrule.

9. Auxiliary supplies of steam should be taken into condensers with the main supply at the top and not separately at the sides.

10. An alteration in water speed may have striking results on the number of tube losses. No general rule can be given in this matter, but trials are worth making when corrosion troubles are serious. If the vacuum in the condenser is low, try raising the speed first, but not above 6 ft. per second; otherwise, try lowering it first. With very high water speeds, such as 10 ft. per second and above, greatly increased trouble is to be expected with arsenical copper tubes, and probably with some other tubes also.

11. Foaming is a serious cause of increased corrosion, so any possible measures should be taken to prevent it (for example, stop any air leaks in pipe line or at pump). Water containing oil is likely to be particularly dangerous.

12. Whenever possible, avoid exposing new tubes to attack by waters likely to be foul (this refers more particularly to condensers on ship board).

Dexter S. Kimball, president of the American Society of Mechanical Engineers, is following the example set by his predecessor, Edwin S. Carmen, and by President Mortimer E. Cooley, of the Federation, by making a "swing around the circle," beginning April 1 and ending April 11. His route is to be through New England, and he will make quite a number of speeches before various local sections and universities.

The Niagara Falls Power Co. has been given authority by the Federal Power Commission to amend its plans so as to install three hydro-electric units of 70,000-hp. capacity each and one forebay, instead of five proposed units of 37,500-hp. capacity each and two forebays.

"To insure yourself of a good obituary notice in the *Bulletin*, remember to pay your back dues, and the second half of your yearly dues at once," suggests a notice in the bulletin of the Engineering Society of Buffalo. Who could resist such an appeal?

News in the Field of Power

C. E. Skinner Rises in Westinghouse Company

C. E. Skinner, internationally known for his research work, particularly on electrical insulation, has been appointed assistant director of engineering by the Westinghouse Electric and Manufacturing Co. He was formerly manager of the research department, which he organized sixteen years ago. His new duties will cover research, standards and similar work in the main engineering offices of the company at East Pittsburgh, Pennsylvania.

Mr. Skinner's entire career has been with the one company. He was born

C. E. SKINNER, WELL KNOWN FOR HIS INSULATION RESEARCH WORK

near Redfield, Ohio, on May 30, 1865, was graduated from Ohio State University in 1890, and in that same year joined the Westinghouse organization in the controller department, where he supervised the construction of the first controller turned out by the company. Soon afterward he was put in charge of the testing of insulation, and in 1892 he was transferred to the research laboratory. Still absorbed in insulation problems more than in other subjects, in 1895 he was placed in charge of insulation design in the engineering department, being made head of the whole insulation division of the department seven years later. In the latter position he was also responsible for the chemical and physical laboratories. In 1906 he organized the research division, becoming manager of it, and it is from that position that he has now been promoted.

His great interest in insulation problems, and the responsibility that was given him for their solution, have resulted in his being known throughout the electrical world for the extensive research work that he has done along those lines, his efforts in that direction having had a marked effect on the development of electrical machine design. He is also known for his frequent contributions to the literature of the electrical industry.

Mr. Skinner has not been lacking in interest in engineering-society affairs, being a fellow of the American Institute of Electrical Engineers and a member of the Franklin Institute, the American Physical Society and the American Society for Testing Materials. He was also a member of the National Research Conference in 1917 and 1918 and of the Advisory Council of the Division of Engineering. In 1915 he went to London as a special representative of the American Institute of Electrical Engineers at the International Conference on Electrical Standards, and he is now a member of the American Institute committee of the International Electro-Technical Commission. He was chairman of the American delegates to the 1920 Brussels meeting.

Pennsylvania O. K.'s Stamp of National Board

Decision has been made by Pennsylvania officials, according to Fred J. Hartman, secretary of the Industrial Board, to this effect:

That Section 13 of the Rules and Regulations of the Administration of the Pennsylvania Boiler Code be interpreted to mean that if the boiler is built under the Pennsylvania Boiler Code or the American Society of Mechanical Engineers' Boiler Code it must be stamped with the A. S. M. E. symbol, and either with the Standard Stamp or the stamp of the National Board of Boiler and Pressure Vessel Inspectors.

This means that a boiler may now be built outside of Pennsylvania, inspected during construction by a local inspector who holds a certificate of the National Board, may be shipped into Pennsylvania and will be accepted by the officials of that state as a standard A. S. M. E. boiler. Previously, the boiler would not have been accepted unless a Pennsylvania inspector had seen it put together.

This decision of Pennsylvania has made it the eleventh state to agree to accept inspections made by officials of the National Board, the other states being Rhode Island, New Jersey, Maryland, Ohio, Indiana, Wisconsin, Minnesota, Oregon, Oklahoma and California. The cities of St. Louis, Mo., and Chicago, Ill., have made the same agreement.

New York, Michigan, Utah, Arkansas and Missouri accept A. S. M. E. standard boilers, but have not yet agreed to accept the stamp of the National Board in lieu of their own stamp.

Death of Henry Baumhart, Boiler Inspection Expert

Henry A. Baumhart, who started in with the Hartford Steam Boiler Inspection and Insurance Co. as a boiler inspector in 1891, died March 17 at his home in Vermilion, Ohio, after an illness of three weeks. His wide experience in boiler engineering made him frequently sought after for advice both by users and by manufacturers of boilers. He was a member of the Ohio State Board of Boiler Rules from its beginning and was for a number of years its vice chairman. He was also a member of the Cleveland Engineering

HENRY BAUMHART, FOR 30 YEARS WITH THE HARTFORD I. & I. CO.

Society and was interested in civic affairs, being a member of the Cleveland Chamber of Commerce. He was a Mason in the Meridian Lodge of Cleveland.

Mr. Baumhart was born April 25, 1862. In his early life he was a chief engineer on the Great Lakes and in 1891 became an inspector of boilers with the Hartford company. In 1902 he was made chief inspector of the Cleveland department of the company, and in 1907 he was made manager of the department, holding that position up to the time of his death.

Affiliation On the Way in Connecticut

Affiliation of the various engineering societies in Connecticut has been proposed and is being studied. About sixteen such societies were represented by fifty members at a meeting that was held in New Haven March 11 to discuss the plan of affiliation. The prevailing sentiment was in favor of the proposi-

tion in principle, but those present felt that the societies of which they were representative ought to be given a fuller opportunity to study the details of the plan, the tentative constitution that was laid before them for their consideration being unacceptable in many respects.

It was voted that a specially appointed committee prepare a final draft to be submitted to each society for ratification. The plan would then go into effect only upon the proposal by a prescribed number of societies.

Discussion and study of the proposition has been in the hands of an affiliation committee, which arranged the recent New Haven meeting. This committee is headed by Harry R. Westcott, temporary chairman, and Prof. E. H. Lockwood, secretary.

Harding Asks Approval for Philadelphia Fair

Another boost has been given Philadelphia's plans for a Sesquicentennial Exhibition in 1926 by President Harding, who has written a message to Congress enthusiastically indorsing the movement and recommending that the project be approved by suitable legislation. The exhibition would commemorate the one hundred and fiftieth anniversary of the Declaration of Independence, and as the President himself agrees, it is altogether fitting that it should be held in Philadelphia, the birthplace of the nation.

President Harding says in the course of his message:

I believe the proposed celebration worthy of the indorsement of the Congress, and I recommend, therefore, the enactment of a suitable measure fixing the year 1926 as the time for commemorating the sesquicentennial of the Declaration of Independence and designating the City of Philadelphia as the place for the official ceremony, and for holding an international exposition in which all the nations may be asked to participate.

An indication of a strong trend that the exhibition may take was given by the President a little farther on in his message, when he said:

Finally, and this I would especially emphasize, it will fittingly signalize a new era in which men are putting aside the competitive instruments of destruction and replacing them with the agencies of constructive peace.

Not long ago the Philadelphia City Council passed a resolution agreeing to back the exhibition to the extent of $5,000,000 and "so much more as may be required," and more recently a site for the fair has been decided upon by the Exhibition Association upon the recommendation of the architects, the real-estate men and the engineers, who formed three active committees to study the situation.

The three committees agreed upon the so-called Fairmount Park, Parkway and Schuykill River site, the chief advantage of which is considered its accessibility. It would cover about 214 acres of land, with 500 acres more available for a zoo and athletic and aviation field.

It is expected that most of the electricity used for the exhibits and for general lighting will be bought from the Philadelphia Electric Co., although a small power plant will be put up for emergency service.

All essential details of the movement were published in *Power* for Jan. 17, 1922, in an article called "What Engineers are Doing for the Sesquicentennial Exhibition."

McGraw-Hill Has Bought Another Paper

The McGraw-Hill Company has bought the *Mining and Scientific Press*, of San Francisco, and on April 1 consolidated it with the *Engineering and Mining Journal* under the name of *Engineering and Mining Journal-Press*. These two publications are the leading magazines of the metal-mining industry, the *Journal* having been established in 1866 and the *Press* in 1860.

J. E. Spurr, editor of the *Journal*, will be editor of the combined weekly, while T. A. Rickard, editor of the *Press*, will be contributing editor, keeping his residence in San Francisco and representing, in particular, the Coast and Western viewpoints. The combined publication will be published in New York.

No Alarm Felt Over Coal Strike in Washington

The dispute between the coal operators and the coal miners does not seem to be causing any alarm on the part of either the public or of Congress. It is evident that the public refuses to be excited over the strike. It is believed that the Union miners could stop work for two or three months before the public would feel the pinch sharply enough to demand interference by the Government. In a statement made March 30, Secretary of Labor Davis declared that there would be no excuse for a rise in soft coal prices for two months.

An opinion quite generally held in Washington in Governmental circles is that the coal operators made a tactical blunder, likely to have far-reaching consequences, by refusing to meet the United Mine Workers' representatives in conference. This has given the miners a strong talking point.

While a decision by the Interstate Commerce Commission on the question of coal freight rates is not hoped for for some weeks, there is a general feeling among traffic men that coal rates may be cut by as much as 20 per cent. There is a growing feeling, however, that the railroads would make every effort to oppose the reduction that may be ordered, and that would mean at least a thirty-day further delay. The attitude of the railroads in the case, it is felt, has lost them many friends; when the roads were turned back to the private companies they had the public with them, but they are apparently losing this support through their bitter opposition of a reduction in rates.

Power Machinery Exports

Of the power-producing and similar machinery produced in the United States in 1919, the following percentages (by value) were exported: Air compressors, 6.5 per cent; elevators and elevator machinery, 4.8; engines, 10.4; pumps and pumping machinery, 13.9; refrigerating machinery, 7.1.

The total value of these exports was $65,941,794, of which $48,370,483 represents engines. The total value of the machinery of this class produced was $671,537,000, which was 29.3 per cent of the value of all the industrial machinery manufactured in the United States in that year.

Obituary

Albert E. Roberts, assistant chief engineer of the Northern New York Utilities, of Watertown, N. Y., was instantly killed March 13 by a 22,000-volt current that passed through a bare copper connector cable in his hands when it came into contact with a choke coil.

John H. Felthousen, chief engineer of the S. Morgan Smith Co., of York, Pa., died recently at the age of 65 years, after a brief illness at his home in York. He was a prominent figure in the hydraulic turbine industry, having been associated with the Smith company for many years in the development of water power equipment.

Personals

Bert H. Shepard has gone into practice as a consulting engineer, with offices in the City Bank Bldg., Syracuse, N. Y.

A. G. Dumbleton, a Tacoma (Wash.) consulting engineer, is investigating a number of sites for a municipally owned power plant.

Edward J. Flynn, an enthusiastic worker for the N. A. S. E. in New Jersey, has gone into private practice as a consulting engineer, having established the E. J. Flynn Engineering Co., of Elizabeth, N. J.

James H. Manning has been appointed engineering manager of Stone & Webster, Inc., with headquarters in Boston. He was formerly assistant engineering manager, and is on the hydraulic power committee, N. E. L. A.

Mitsuichi Ohshima, hydraulic engineer of the Shinyetsu Electric Power Co., Tokyo, expects to visit a number of Eastern manufacturing centers in the interests of his company, which has planned a ten million dollar expansion program.

C. W. E. Clarke, power engineer, of Dwight P. Robinson & Co., Inc., left New York March 21 on the "Aquitania" for one of his periodical inspection trips of central power stations in England and on the Continent. He will spend about six weeks studying power-station design and operation in England, France and Germany.

Society Affairs

Coming Conventions

American Institute of Electrical Engineers, 29 West 39th St., New York City. Spring convention at Chicago, April 19-21.

American Society of Mechanical Engineers, 29 West 39th St., New York City. Spring meeting at Atlanta, Ga., May 8-11.

American Water Works Association, 153 West 71st St., New York City. Annual convention at Philadelphia, May 15-19.

National Electric Light Association, 29 West 39th St., New York City. Annual convention at Atlantic City, N. J., May 15-20.

Baltimore Election, A. S. M. E., will meet April 12 at the Engineers' Club for a lecture by J. R. McDermott, of the Elliott Co., on "The Separation of Dissolved Gases from Water and its Relation to Power Plant Apparatus."

Lehigh Valley Section, A. S. M. E., will meet April 11 at Lehigh University, Bethlehem, Pa., to discuss "Coal." One of the papers will be on "Economy in the Use of Coal under Boilers," by D. L. Jones, of the Automatic Fuel Saving Company.

Boston Section, A. S. M. E., is to hold a joint meeting with several student branches April 8, at which President Kimball will speak on "Engineering and Citizenship" and the Sanford Riley motion picture of stoker operation will be shown.

Metropolitan Sections of the four founder societies are to devote their April 14 meeting to the general subject of "The Muscle Shoals Development from an Economic Point of View." Motion pictures showing development of the project to date will be shown; "Muscle Shoals as a Power Producer" will be the title of Brigadier Gen. Harry Taylor's paper; and "Muscle Shoals as a Nitrate Producer" will be treated from the angle of commercial nitrates by C. W. Stowell, chief engineer of the American Cyanamid Corp., and from the angle of military nitrates by Gen. C. C. Williams, Chief of Ordnance, U. S. A.

Student Branches of the A. S. M. E. in the New York metropolitan district will meet in the afternoon and evening, April 7, in the Engineering Societies Building, New York City. "The Port of New York" and "Engineering Finance" will be discussed from 4 to 6 p. m. At 8 o'clock "The St. Lawrence River Project" will be debated by H. I. Harriman, formerly president of the Boston Chamber of Commerce, (favorable) and by Harrison H. Wheaton (opposed).

Business Items

Ophuls, Hill & McCreery have bought the interest of J. Harold McCreery and have applied to the state for a change in character to Ophuls, Hill, Inc. They expect to continue business at the same location and with the same personnel, Fred Ophuls being president and Halbert P. Hill vice president and treasurer.

The Diamond Power Specialty Corporation, Detroit, Mich., is a new company that has bought out the soot-blower business of the Diamond Power Specialty Co., the members of which are retiring from the soot-blower business. Norman L. Snow, who has been connected with the Terry Steam Turbine Co., of Hartford, Conn., for the last thirteen years, has resigned as vice-president and active head of that company to become president and treasurer of the new corporation.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	March 20, 1922	March 27, 1922
Pool 1,	New York	$2.85	$2.75@3.00
Pocahontas,	Columbus	1.85	1.65@1.90
Clearfield,	Boston	1.95	1.65@2.25
Somerset,	Boston	1.90	1.75@2.00
Pittsburgh,	Pittsburgh	2.00	1.80@1.90
Kanawha,	Columbus	1.50	1.40@1.65
Hocking,	Columbus	1.75	1.65@1.90
Pittsburgh No. 8	Cleveland	1.90	1.80@1.90
Franklin, Ill.,	Chicago	2.50	2.00@2.50
Central, Ill.,	Chicago	2.35	2.10@2.40
Ind. 4th Vein,	Chicago	2.45	2.25@2.50
Standard,	St. Louis	1.80	1.80@1.90
West Ky.,	Louisville	1.75	1.65@1.90
Big Seam,	Birmingham	1.85	1.70@2.00
S. E. Ky.,	Louisville	1.60	1.50@1.60

New York—On March 29, Port Arthur light oil 22@25 deg. Baumé 3⅞c. per gal. 30@35 deg., 4¾c. per gal., f.o.b. Bayonne, N. J.

Chicago—Mar. 8, for 24@28 deg. Baumé, 85@90c. per bbl.; 21@36 deg., 2⅜@2½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Mar. 28, f.o.b. refinery, Pennsylvania, 36@40 deg. 4¼@4½c. Kentucky fuel oil, 26@30 deg., 3c. per gal. Western, 24@30 deg., 80c. per bbl.; 32@34 deg., 2¾c.; 36@38 deg., 3c.; 38@40 deg., 3¼c. per gal.

St. Louis—Mar. 25, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 90c. per bbl.; 26@28 deg., 95c.; 28@30 deg., $1.10; 32@34 deg., 2¾c. per gal.

Philadelphia—On Mar. 27, 26@28 deg. Baumé, Oklahoma, 85@90c. per bbl.; 30@34 deg., Oklahoma (group 3) 2¼@3c. per gal.; 16@20 deg. Seaboard, $1@1.10 per bbl.

Cincinnati—Mar. 21, for 26@30 deg. Baumé, 4c.; Diesel 32@34 deg., 4¼c. per gal.; distillate 38@46 deg., 5c. per gal.

Cleveland—Mar. 21, 26@30 deg. Baumé, 3c. per gal.

New Plant Construction

PROPOSED WORK

Cal., San Diego—The San Diego Gas & Electric Co. has had designs made by Requa & Jackson, Archts., 614 B St., for a 45 x 95 ft. sub-station on 4th and Ash Sts. Byllesby Engr. & Management Corp., 208 South La Salle St., Chicago, in charge of plans and installation of equipment. Total cost about $200,000.

Cal., San Francisco—The city and County will receive bids until April 12 for a 2 story school on 22nd and Valencia Sts. About $400,000. J. Reid, Jr., First Natl. Bank Bldg., Archt. Noted Feb. 14.

Cal., San Francisco—L. Fritz, 116 Frederick St., is having plans prepared for an 8 story apartment on California St., between Mason and Taylor Sts. About $350,000. E. N. Fritz, 116 Frederick St., Archt.

Cal., San Francisco—M. A. Little, c/o E. E. Young, Archt., 251 Kearny St., is having plans prepared for a 10 story apartment on Geary and Shannon Sts. About $275,000.

Conn., Hartford—Buck & Sheldon, Inc., Archts. and Engrs., is receiving bids for a 4 story, 80 x 400 and 80 x 100 ft. factory including a steam heating system on Windsor Ave. for the Fuller Brush Co., Asylum St. About $400,000. Noted Sept. 6.

Conn., Hartford—(Change of date)—The High School Plant and Bldg. Comn., W. H. Scoville, Chn., will receive bids until April 25 for a 3 story high school including a steam heating system and ventilating system on Greenfield and Ridgefield Sts. About $1,500,000. F. I. Cooper Corp., 33 Cornhill, Boston, Archts. Noted March 28.

D. C., Washington—The Chamber of Commerce of the U. S., L. A. Skinner, Mills Bldg., Sec'y, having plans prepared for the construction of an office bldg About $1,500,000. C. Gilbert, 244 Madison Ave., New York City, Archt.

Fla., Seabreeze—The city, P. D. Gold, Mayor, voted $50,000 bonds for waterworks with softening plant, 75,000 gal. tank on 125 ft. tower, driven wells, pumping house, pumps, etc.

Fla., St. Petersburg—The investigating Committee has recommended to the City Commission the construction of a 1,500 kw. electric power plant, including 3 diesel oil engine generating units of 500 kw. each, 2 rotary converters, switchboard and complete equipment. R. E. Ludwig, Dir. Pub. Utilities.

Fla., Tampa—The Tampa Electric Co., T. J. Hanlom, Jr., Mgr., plans an addition to lighting plant including pumps and auxiliary equipment for boilers on Jackson St. About $38,000.

Ga., Atlanta—The Southern Development Co. is having plans prepared for a 9 story apartment near Piedmont Park. About $900,000. W. J. Wilkins, Wilmington, N. C., Archt.

Ill., Chicago—A. S. Alschuler, Archt., 28 East Jackson Blvd., is receiving bids for a 6 story, 125 x 125 ft. printing plant including a steam heating system on Jackson Blvd. and Laflin St. for the U. S. Sample Co. About $350,000.

Ill., Chicago—T. R. Bishop, Archt., 38 South Dearborn St., is receiving bids for a 3 story, 120 x 130 ft. apartment including a steam heating system on 70th St. near Crandon St. for A. E. Sward. About $500,000. Noted Feb. 28.

Ill., Chicago—Davidson & Weiss, Archts., 53 West Jackson Blvd., are receiving bids for a 10 story, 100 x 100 ft. office bldg. including a steam heating system on Harrison and Clark Sts. About $450,000. Owner's name withheld.

Ill., Chicago—C. S. Frost, Archt., 105 South La Salle St., is receiving bids for a 3 story, 71 x 135 ft. office bldg. including a steam heating system at 1400-6 Washington Blvd. for the Public Life Insurance Co., c/o L. Norowetz, 1711 Park Ave. About $360,000.

Ill., Oak Park, Chicago—Minchin-Spitz & Co., Archts., 18 West Jackson Blvd., are receiving bids for a 3 story, 150 x 175 ft. apartment including a steam heating system for A. Eldredge. About $275,000. Noted March 21.

Ill., Chicago—Newhouse & Bernham, Archts., 4630 Prairie Ave., are receiving bids for a 2 story, 60 x 170 ft. ice cream factory (1st unit) on Federal and 45th Sts. for the Goodman American Ice Cream Co., 100 West 45th St. About $75,000. Total cost $400,000.

Ill., Rock Island—(Change of date)—Cervin & Horn, Archts., 310 Safety Bldg., will receive bids until April 6 for a 2 story seminary and dormitory bldg. for the Augustana College. About $400,000. Noted Mar. 7.

Ill., Rock Island—The Peoples Power Co. is having plans prepared for an addition to power house, including boiler room and electrical equipment, extending light service, poles and wires, etc. Total cost about $269,000. Private plans.

Ind., Indianapolis—R. N. Edwards Co., Archts., Union Trust Bldg., is preparing plans for a 1 and 3 story, 150 x 200 ft. manufacturing plant to include a power plant, etc. About $250,000. Owner's name withheld.

Kan., Holton—The city will receive bids until April 10 for one 100 kw. unaflow engine and generator. Black & Veatch, Mutual Bldg., Kansas City, Mo. Engr.

La., New Orleans—The Sewerage and Water Bd., 526 Carondelet St., received bids for two 36 in. pumps of from 30,000,000 to 40,000,000 gal. capacity per 24 hr. and two motors from D'Olier Centrifugal Pump and Machinery Co., 155 Bway., New York City, $9,000; Aurora Pump Mfg. Co., Aurora, Ill., $9,648; and Hoover, Owens Rentschler Co., 4th and Heaton St., Hamilton, O., $9,710; Two boilers of 1,500 and 1,800 hp. capacity from Lasker Iron Wks., 3201 South Lincoln St., Chicago, Ill., $28,915; Babcock & Wilcox Co., 521 Baronne St., New Orleans, La., $32,133; and Badenhausen Co., 1425 Chestnut St., Phila., Pa., $32,400. Electrical equipment from the Westinghouse Electric & Mfg. Co., Maison Blanche Bldg., $20,175; and the General Electric Co., New Orleans, $26,500.

Mass., Boston—(Change of date) The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until April 12 for coal handling equipment. Noted Mar. 14, Spec. 4583.

Mich., Pontiac—Smith, Hinchman, Grylls, Archts., 710 Washington Arcade Bldg., Detroit, will receive bids until April 18 for an 8 story, 60 x 145 ft. bank and offices bldg. including a steam heating system, boiler and equipment for the Alverdo Bldg. Co. About $400,000.

Minn., Alexandria—The city voted $30,000 bonds to equip electric light plant with new turbine unit. C. L. Pillsbury Co., 1200 2nd Ave., S., Minneapolis, Engr.

Minn., Minneapolis—The Fulton Bag & Cotton Mills, 643 Security Bldg., V. C. Douglas, representative, is having plans prepared for a 3 story factory and administration building on East Hennepin Ave. and Taft St. About $300,000. Kees & Colburn, 245 Plymouth Bldg., Archts.

Minn., Minneapolis—The Norwegian Lutheran Deaconess Hospital, F. Paulson, Supt., 2312 15th Ave., S., is having plans prepared for a 2 story, 45 x 75 ft. power house, laundry and dormitory on 15th Ave. S. and 24th St. About $45,000. Magney Tusler, 126 South 9th St., Archt.

Mo., Kirksville—The Northeast Missouri State Teachers College, J. Kirk, Pres., will receive bids until April 11 for 2 story gymnasium, auditorium and demonstration buildings. About $287,000. R. N. Sanneman, 519 Lee Bldg., Kansas City, Archt.

Neb., Lincoln—The Bd. Educ., J. G. Ludlam, Secy., 15th and N Sts., will receive bids until April 27 for heating, ventilating and plumbing for Whittier Jr. High School on 22nd and Fulton Sts. Fiske & Meginnis, 533 Bankers Life Bldg., Archts.

N. J., Trenton—The City Comn., plans to purchase a Root rotary pump for city pumping station. About $60,000.

N. Y., Attica—The village is having plans prepared for a high school. About $300,000. Private plans.

N. Y., Batavia—The Gyposlite Co., Inc., c/o J. Haggerty, 604 Woodlawn Ave., Buffalo, is in the market for two 150 hp. boilers.

N. Y., Brooklyn—The Universal Hardware & Supply Co., 79 Greenpoint Ave., is in the market for a 35 hp. slide valve steam engine.

N. Y., Canandaigua—The Tobin Sash Co. plans to change power from gasoline to electric and is open for quotations and catalogs.

N. Y., Hornell—The Bd. Educ., will receive bids until April 13 for a high school. About $450,000. Tooker & Marsh, 101 Park Ave., New York City, Archts. and Engrs. Noted Feb. 14.

N. Y., Medina—The Bd. Educ. will receive bids until April 11 for a 3 story, 180 x 200 ft. high school. About $350,000. W. B. Ittner, 408 Bd. Educ. Bldg., St. Louis, Mo., Arch. Separate contracts for heating and ventilating.

N. Y., New York—P. Meirowitz, 530 Manhattan Ave., plans to build a 12 story apartment at 1240 Madison Ave. Architect not selected.

N. Y., Owego—The Bd. Educ., G. S. Decker, Pres., is having sketches made for a 3 story, 150 x 200 ft. school including a steam heating system. About $275,000. Coffin & Coffin, 522 5th Ave., New York City, Archts. and Engrs.

N. Y., Penn Yan—The city, C. N. Bacon, Pres., plans to install motor driven pump for water department. About $4,000.

N. Y., Rochester—D. A. Hill, 420 Plymouth Ave., is in the market for an upright boiler, about 8 hp. capacity.

N. Y., Troy—A. D. Colehamer, 428 River St., is in the market for an 80-100 hp. portable boiler and engine.

N. C., Wendell—The North State Power Co., H. Couch, 118 West Martin St., Raleigh, N. C., genl. mgr., is receiving bids for a 27 x 36 ft. power house to include two semi deisel fuel oil engines to develop 100 hp. About $35,000.

O., Cleveland—J. P. Stotter, 4319 Prospect Ave., is having plans prepared for a 3 story, 100 x 220 ft. apartment including a steam heating system on East Blvd. and Superior Ave. About $300,000. S. H. White, 1032 Schofield Bldg., Archt.

O., Salem—The city plans reservoir, tank house, pipe lines, etc. to include 3 deep well pumps. About $500,000. M. Knowles, Jones Law Bldg., Pittsburgh, Pa., Engr.

O., Youngstown—The First Natl. Bank has had plans prepared for a 16 story, 42 x 200 ft. bank and office building including a steam heating system on Federal St. About $2,500,000. Walker & Weeks, 1900 Euclid Bldg., Cleveland, Archts. Clark, MacMillan & Riley, Marion Bldg., Cleveland, Htg. Engrs.

Pa., Greensburgh—E. L. Tilton, Arch., 141 East 45th St., New York City, will receive bids until April 15 for an addition to hospital for the Westmoreland Hospital here. About $500,000. Noted Feb. 14.

Pa., Newton Square—C. Brozer, Archt., Chester, will receive bids until April 15 for a 3 story, 30 x 280 ft. and 26 x 40 ft. home, power house and laundry for the Dunwoody Home. About $350,000.

Pa., Phila.—The city will soon receive bids for a 60 x 100 ft. pumping station at Cannon Ball farms. J. A. Vogelson, City Hall, Engr.

Pa., Phila.—The Girard Trust Co., Broad and Chestnut Sts., is having plans prepared for an addition to bank and office building including a steam heating system on Broad St. About $500,000. McKim, Fread & White, 101 Park Ave., New York City, Archts. and Engrs.

R. I., Providence—The Dept. of Public Buildings, plans to build a 2 story central heating plant. About $350,000. Private plans.

S. C., Newberry—The Newberry Lumber Co., is in the market for boilers and engines for woodworking plant.

Tenn., Nashville—Caldwell & Co., 214 Union St., is having plans prepared for a 10 story bank on 4th and Union Sts. About $500,000. Marr & Holman, Stahlman Bldg., Archts.

Tex., Austin—N. K. Brown, State Hwy. Dept., is in the market for a 10 ton ice manufacturing plant.

Tex., Mt. Pleasant—The city plans improvements to waterworks including enlarging mains, filtration plant, pumping plant, stand pipe and new machinery. About $150,000. H. S. Wilder, Engr.

Va., Norfolk—C. E. Ashburner, City Mgr., will receive bids until April 11 for a 3 story, 100 x 300 ft. city market on Tazwell, Market and Brewer Sts. and Monticello Ave. Cost between $300,000 and $350,000. Heating and ventilating system will be separate contract. Bids will be received later for refrigeration machinery and equipment. Noted Jan. 24.

Va., Pennington Gap—The town plans installation of waterworks, pump house, reservoir, etc. About $40,000.

Va., South Hill—The town plans power house, water and lighting system. About $125,000. Engineer not announced.

Wash., Tatoosh Island—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., received bids for operating and power building, water and sewer system from B. Ward, 418 Peoples Bank Bldg., Seattle, Wash., $14,880.85; W. F. Martins, 112 Cutler Bldg., Rochester, N. Y., $18,613 and G. E. Wright, Inc., 1454 Monadnock Bldg., Chicago, Ill., $18,950. Noted Feb. 21, Spec. 4574.

W. Va., Richwood—J. L. Horner Ice Co. Clarkesburg, plans the construction of a 10 ton ice plant here.

Wis., Delavan—The Water Comn., K. Hollister, Clk., will receive bids until April 7 for a 30-in. diameter open well, pumping station and ¼ mi. of 8 in. force main also 400 gal. per min. motor driven centrifugal pump. W. Pierce, Delavan, Engr.

Wis., Fond-du-Lac—The Harcum Fuel Co., 35 West 1st St., will receive bids about April 10 for machinery and equipment for 4 storage elevators, about 1,000 ton. capacity. Private plans.

Wis., Madison—The city, H. C. Buser, Clk., is having plans prepared for the installation of 30 arc lights and necessary equipment. E. E. Parker, City Hall, Engr.

Wis., Madison—The Madison Gas & Electric Co., 120 East Main St., is having plans prepared for a 1 story, 50 x 65 ft. power house including 1,000 hp. sterling boiler, 5,000 kw. turbine coal handling machinery, on East Main St. About $50,000. Mead & Seastone, State Journal Blk., Engr.

Wis., Sheboygan—The Eastern Wisconsin Electric Co., 8th and Penn Aves., plans to extend tracks on Union Ave. and other streets and erect power line to extend to 12th St. About $75,000. Private plans.

Ont., London—G. Little, Robinson Little Co., 343 Richmond St., plans to build an arena. About $150,000. Prices wanted on artificial ice making equipment.

Ont., St. Catharines—The Bd. Educ. C. T. McBride, 13 Welland Ave., Secy., will receive bids until April 11 for a 3 story, 175 x 313 ft. school including a steam heating system with temperature regulators and mechanical equipment, on Geneva St. About $600,000. S. B. Coon & Son, 4 St. Thomas St., Toronto, Archts.

CONTRACTS AWARDED

Cal., Yountville—The State will build a power plant at the Veterans home. About $40,000. G. B. McDougall, Forum Bldg., Sacramento, State Archt. Work will be done by force account.

Ill., Chicago—P. F. Olsen, 127 North Dearborn St., has awarded the contract for a 3 story, 200 x 206 ft. apartment on Jonquil and North Hermitage Sts. to J. Anderson & Co., 5723 Winthrop Ave. About $300,000. A steam heating system will be installed.

Ind., Indianapolis—J. F. Wild & Co., 123 East Market St. has awarded the contract for a 12 story, 85 x 120 ft. bank and office bldg. on East Market St. to the Bedford Stone & Constr. Co., Fletcher Trust Bldg. About $1,000,000. Noted Feb. 28.

Mich., Detroit—The Bd. Fire Comrs., Larned St. Station, has awarded the contract for furnishing 3 high pressure pumps for high pressure water system for pumping station at foot of Randolph St. to the Midwest Engine Co., 19th St., Indianapolis, Ind., $25,980.

N. Y., New York—The Bing & Bing Constr. Co., Inc., 119 West 40th St., will build an apartment on 85th St. and Park Ave. About $750,000. Owner will build by separate contracts.

N. Y., New York—The Bronx Boosters Inc., c/o Maynicke & Franke, Archts., 25 East 26th St., has awarded the contract for a 10 story, 122 x 246 ft. hotel on the Grand Concourse between 161st and 162nd Sts. to Niewenhous Bros., 316 East 161st St. About $750,000. Noted Mar. 23.

N. Y., New York—S. A. Herzog Constr. Co., 299 Madison Ave., will build an apartment at 933 Park Ave. About $600,000. Owner will build by separate contracts. A steam heating system will be installed.

N. Y., New York—The Ogden Amusement Co., c/o E. DeRosa, Archt., 110 West 40th St., has awarded the contract for a theatre on 171st St. and Ogden Ave. to M. Shapiro, 103 West 46th St. About $400,000. Noted Oct. 25.

S. D., Watertown—The city, G. K. Burt, Secy., Public Utilities Comn., has awarded the contract for an electric distribution system to A. E. Champlin Co., Fargo, N. D., $88,375, residential street lighting system to S. H. Addison, Watertown, $41,000. Noted Dec. 20.

Wis., Sheboygan—H. C. Prange Co., 8th and Wisconsin Aves., has awarded the contract for a 3 story, 65 x 90 ft. power and heating plant on 8th St. to the Lake Shore Constr. Co., 805 Michigan Ave. About $60,000. Noted March 7.